THE AMERICAN GAS LIGHT JOURNAL

VOL. CIV., No. 4. NEW YORK, JANUARY 24, 1916. WHOLE No. 3,040.

GAS FIRED STEAM RADIATORS FOR HEATING APARTMENT HOUSES. A SUCCESSFUL INSTALLATION.

By H. THURSTON OWENS.

Gas is being successfully used for heating in nine apartment houses erected during the past year in the Long Island City section of New York City. "Gas will be the fuel used exclusively for heating in homes and apartments in the near future, and we are now using it in all of our new buildings," was the expression of Mr. Gustav Erda, architect of the buildings referred to.

AN EXAMPLE OF THE NECESSITY OF PIPING BUILDINGS THROUGHOUT FOR GAS.

The first of these buildings, known as the Winston, shown in the illustration Fig. 1, is located at Van Alst ave., N. W. corner 12th street, Long Island City, N. Y., erected early in 1915, contains 63 apartments of 3, 4 and 5 rooms, which rent for from $4.50 to $5.00 per room, per month. In each living room and dining room there is a gas-fired steam radiator, and the kitchens are equipped with coal ranges and gas cookers. The gas for the radiators is metered to the tenants. The main halls and the bath rooms are heated with hot water heat supplied by the owners.

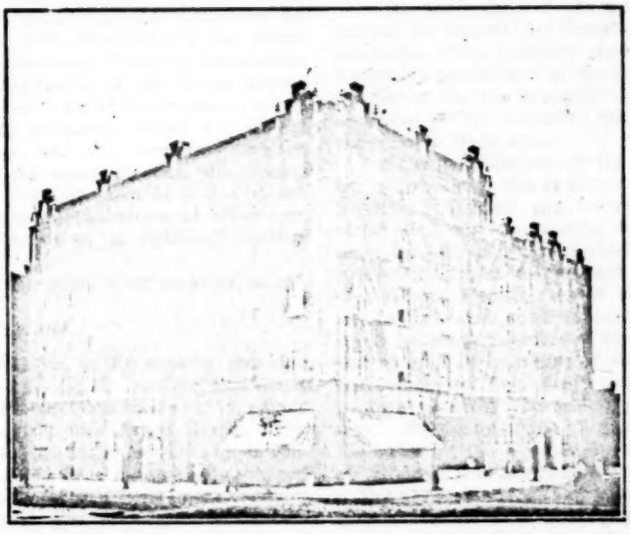


Fig. 1.—One of a group of Apartment Buildings in which heat is furnished by City Gas.

The system has proven successful as far as the tenants are concerned, as they can obtain heat at small expense whenever they want it. The owners are satisfied, as the cost of heating is reduced, and there are fewer complaints from the tenants, consequently it is easier to obtain and keep good janitors.

When apartments are heated from a central heating plant in the cellar, the tenants are always at the mercy of the janitor, and it is impossible to satisfy all of them all the time. Some wish heat late at night, others early in the morning, and if the heating system is not properly installed some of the apartments are too hot, while others are too cold, and the pipes thump at the most unexpected times; these objections do not occur when gas-fired steam radiators are used. The cost of installation of the kind referred to is about the same as the older type of cellar supply systems, the additional cost of the gas radiators being off-set by the saving in steam piping.

The gas-fired steam radiator is a portable steam generator for room heating, and consists of a cast iron radiator of conventional type—see Fig. 2—beneath which is a combustion chamber containing a gas burner—see Fig. 3. The work of the appliance is to supply heat from a small quantity of water placed within the radiator, the steam being generated by means of the gas burner. The appliance performs the function of a one pipe steam heating system, the boiler and radiator being combined in one, so that no intermediate piping is necessary, and no heat is lost in transmission. The radiator is so designed that it can be used independently, or connected to a central heating one pipe system, the gas burner to be used as an auxiliary when the main boiler is not in operation. The radiator is equipped with a positive air valve, and a regulator actuated by the steam pressure controls the gas supply—Fig. 4—reducing the gas so that the steam pressure will be about 5 pounds per square inch, and an overflow filling cup which shows the water level when the cover cap is removed.

The more important details of the construction are the pilot lighter, the safety valve and the all metal gas control valve. The design and location of the burner permits of a complete combustion, with consequent absence of odor from this cause, both at the full and shut off consumptions, and the burner is properly proportioned so that flash backs cannot occur.

The air valve is of the positive type, and the gas orifice is fixed—which assures satisfactory operation of the burner, as does also the rigidity of the piping which insures the gas jet being centrally located in the neck of the burner, which is important for complete combustion in a blue flame burner.

Water is placed in the radiator through the filling cup, which, when full, indicates that the water in the radiator is at the proper level. No gauge glass is provided, the water being observed by removing the cap of the filling cup, which should be done about once a week until the interval of time necessary for refilling the radiator is determined, which in some cases is necessary only once or twice during the entire heating season. The radiators are made in two styles, the details being as follows:

Style.	Height.	Number of Sections.	Radiation Surface per Section.
High	37 inches	4—6—8—10	6 feet
Low	23 inches	4—6—8—10	4 feet

In calculating the radiation required for a room the following formula is recommended by the manufacturers:

For Glass.....	1	sq. ft. of radiation for each	2	sq. ft. of glass.
Double glass..	"	"	3	"	"
Exposed wall..	"	"	20	"	wall.
Cubical contents..	"	"	200	cubic feet.	

Most of the radiators used in the installations spoken of are 6 section high type.

The buildings referred to are located in Long Island City as follows:

Van Alst avenue, N. W. C. 12th street.
" " No. 227.
12th street, No. 105.
5th avenue, Nos. 155 and 157.
" S. E. C. Graham avenue.
" No. 230.
7th avenue, No. 543.
" S. W. C. Van Deventer avenue.

Gas is supplied by the East River Gas Company, the rate being 80 cents per 1,000 cubic feet. The radiators were supplied by Messrs. J. B. Slattery & Bro., Inc.

The gas piping necessary for the heating system costs very little to install, as it merely requires extending the kitchen fuel lines or the lighting lines, a fraction of 1% of the total cost of the building. The success of these installations is one more proof of the necessity of piping modern buildings throughout for gas.

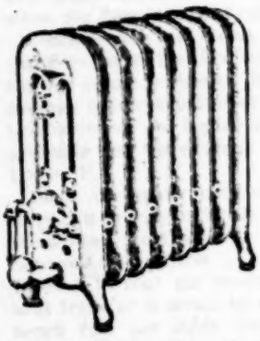


Fig. 2.—These radiators look like those used for ordinary steam heating systems.

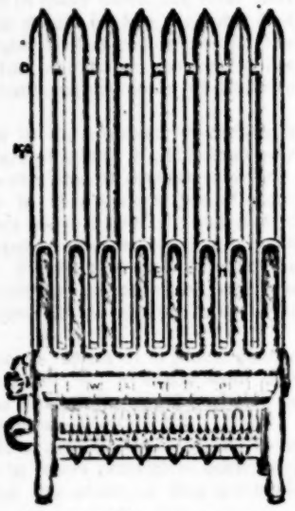
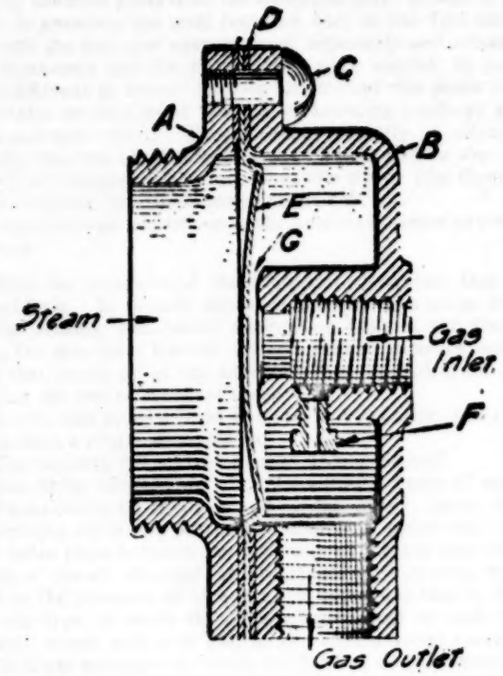


Fig. 3. The gas burner is governed to maintain 5 pounds steam pressure.



Automatic Gas Control Valve
Economic Gas Fired Steam Radiator

Fig. 4.

A—Shows screwed connection for attaching valve to radiator.
B—Is the outer part of the valve casing.
C—Bolts for securing the flanges.
D—Gaskets with heat resistance to 1,000° F
E—Metal diaphragm formed to permit of a spring movement.
F—Removable by-pass which is a standard stove spud in the main gas-way.
G—Space between the main gas-way and the diaphragm E, which varies according to the steam pressure. When 5 pounds pressure is reached this space is closed and burner operates from the by-pass only.

Firebrick for Boiler Furnaces.

Firebrick that proved satisfactory with old-style boiler furnaces may not be at all desirable with modern furnaces and high temperatures. Chemical analysis and fusion temperatures are not reliable indications of the refractoriness of a firebrick in service, for structural differences have an effect on wearing qualities. The following properties must be possessed by a refractory:

1. Absolute infusibility at the highest working temperatures.
2. Absence of deformation and shrinkage under working conditions.
3. Mechanical strength.
4. Complete resistance to the penetration of vapors, slags, etc.
5. A chemical composition fitted to withstand the corrosive action of the substances to which the bricks are exposed.
6. Uniformity in shape and dimensions.
7. Resistance to erosion.
8. The ability to withstand sudden temperature changes without spalling.

The following melting points of various bricks are given in Technological Paper No. 10 of the Bureau of Standards:

	Melting Point, Deg. F.	Chemical Nature.
Fireclay	2863-3169	Neutral or acid.
Bauxite	2881-3277	Basic or neutral.
Silica	3092-3101	Acid.
Chromite	3754	Neutral.
Magnesia	3993	Basic.

Iron, silica, alumina, lime and sulphur are the clinker-forming elements of coal; the degree of fusibility of the clinker varying directly as the percentages of sulphur, iron and lime and inversely as the silica and alumina. The tendency of iron to combine with the silica in the coal and ash to form a slag is well known, and a cinder of this kind will have a strong affinity for the silica in the brickwork. Cinder in furnaces often sticks to the brickwork, which is damaged in barring the clinker loose. With certain kinds of cinder, it is possible to feed a small quantity of limestone and melt a pasty slag from the side walls. Fluorspar has a similar effect upon some cinder. These remedies should be used with discretion, to avoid fluxing the cinder to such an extent that it will flow down on the grate bars and chill there, as it will be more troublesome than in its original condition.

There is no reason why silica brick should not be used above the cinder line, where they are exposed to the flame only.

Bauxite brick have been tried for side walls of fireboxes. They cost from two to three times as much as silica or high grade fireclay brick, are hard and tough, cinder does not stick to them, and they last considerably longer than silica brick exposed to the action of the slag. They have the disadvantage of a tendency to spall if suddenly chilled. The barring doors are generally close to the side walls, and when the furnace is below atmospheric pressure, the chilling draft results in rapid spalling close to the door. Bauxite brick, even with this disadvantage, has proven quite durable, lasting from three to eight times as long as cheaper brick. Although bauxite is extremely refractory, it must be carefully calcined, or it will shrink excessively at furnace temperatures. The brick must be burned in an oxidizing atmosphere, otherwise the iron compounds will be reduced and the brick will have low heat resistance. Bauxite brick are frequently considered as basic, though in many ways they partake of a neutral character. The average composition of bauxite from Georgia is:

Silica (SiO_2)	3.00%
Iron peroxide (Fe_2O_3)	1.50%
Alumina (Al_2O_3)	58.67%
Water (H_2O)	32.33%
Titanium oxide (TiO_2)	4.50%

Another material that has some possibilities in building durable fireboxes is chrome iron ore or chromite. The brick cost twice as much as bauxite brick, but are neutral. The material is infusible and it is difficult to sinter it thoroughly, and unless thoroughly sintered it does not stand erosion.

HISTORY OF THE DEVELOPMENT OF WATER GAS.

Paper by O. B. EVANS, to the International Gas Congress.

Some very complete papers have already been published dealing with the history of water gas, among which may be mentioned the following:

In 1889 Mr. F. H. Shelton presented to the American Gas Light Association a history of "Illuminating Water Gas—Past and Present;" Dr. A. C. Humphreys, the same year, read before the British Association for the Advancement of Science, a paper on "Water Gas in the United States;" the *Progressive Age* in 1894 published an article covering the history of water gas from the time of Mr. Shelton's paper to that date; and in 1909 Mr. F. N. Morton prepared for the AMERICAN GAS LIGHT JOURNAL, "A Half Century's History of Water Gas."

These contributions contain full descriptions, with illustrations, of most of the various types that received trial during earlier days of the development of carbureted water gas, and any one interested in a particular design of apparatus is referred to them. It is the purpose of this paper to sketch briefly the early history, to describe some of the more important types of apparatus and attempt to show the fundamental principles underlying their operation, to give the reasons for the abandonment of such of the types as have failed to survive, as well as to point out how the various modifications have served to make the modern apparatus the satisfactory and efficient machine that it is.

EARLY HISTORY.

The basis of water gas was discovered by Fontana, who in 1780 proposed to manufacture a gas by passing steam over incandescent carbon. Experiments by Cavendish, Lavosier, Meusnier, and others, rapidly followed, so that the discovery of water gas may be said to be contemporaneous with that of coal gas; for it was in 1783 that Wm. Murdock first applied the "vapor" distilled from bituminous coals to the lighting of his house.

While some very early patents were granted for the manufacture of water gas, the credit for its first commercial use apparently belongs to Michael Donovan, who in 1830 distributed it for public lighting in Dublin, Ireland. Unfortunately, however, his attempt was not a permanent success. A description of his process states:

"This invention relates to the enriching of those gasses which afford little light while burning, by substances which will impart to them a higher illuminating power, and may consist in bringing the gas produced by the action of the steam on coke, etc., heated to redness, into contact with the liquid or vapor of spirits of turpentine, spirits of tar, coal naphtha, naphthalene, or other substances, heated or otherwise, and employing the combined mixture as the illuminating agent."

This seems to be the first attempt to make what we know as carbureted water gas.

RETORT SYSTEMS.

One of the first water gas installations in this country was that of Dr. J. M. Sanders, erected in Philadelphia in 1858, to supply gas to the Girard House. This apparatus, shown in Fig. 1, consisted of a number of L-shaped cast iron retorts in an ordinary coal gas setting. The retorts were filled with charcoal and externally heated. Superheated steam, together with melted rosin, was admitted to the top of the retorts, and the steam decomposed in passing down through the bed of charcoal, the rosin furnishing the necessary illuminating power.

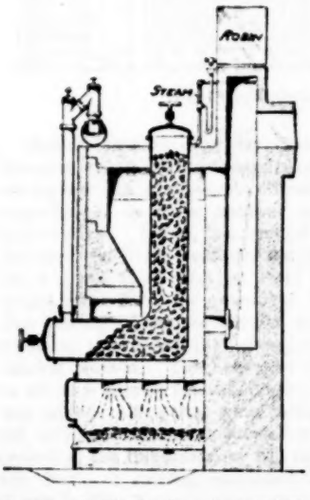


Fig. 1.—J. M. Sanders Apparatus.

This process caused much discussion in the daily papers and in the technical journals, and vigorous though unsuccessful attempts were made to have it replace the coal gas benches in the municipal plant. No satisfactory tests seem to have been made with it, the published results indicating, however, the use of about 10 pounds of rosin per pound of charcoal, and the production of a gas of about 10% greater candle power than that from coal. The gas was not a stable one, and this, together with the necessity for the frequent renewal of the metal retorts, practically killed the process.

The Gwynne-Harris, later called the Allen-Harris, system was about the only one to attract public attention between 1858 and 1875. This system consisted in filling one or more retorts of an ordinary coal gas bench with anthracite coal, and the remaining retorts with gas coal. Superheated steam was passed through the layer of anthracite coal, and the water gas so generated introduced into the coal gas retorts, the mixture of water gas and coal gas discharging into the hydraulic main in the usual way. An elaborate set of experiments was conducted upon the Fair Haven plant, and reported in the AMERICAN GAS LIGHT JOURNAL of January 16, 1874. In the report it was claimed that the admission of blue water gas to the coal gas retorts increased the quantity of gas about 40%, with no appreciable loss in candle power; that is, there was an increase in candle feet of about 40%. Much of this increase was attributed to the distillation of the coal in an atmosphere of water gas, whereby some of those hydrocarbons that usually broke down into tar were protected from such decomposition and retained in the gaseous form. That this action took place seemed to be confirmed by the statement that the yield of tar was about 2 gallons per ton less than with the straight coal gas process.

It is interesting to note that in 1900 Mr. V. B. Lewes, in a lecture before the Incorporated Institution of Gas Engineers, advocated the introduction of water gas into coal gas retorts to improve results. Such a system has been used with varying success, and has been the basis for much heated discussion. It is still apparently a question whether the method does or does not possess the merits claimed for it.

In the early days of the petroleum industry the refiner did not possess his present day knowledge, which enables him to vary the quantities of his products according to the demand, and hence the increasing production of the desirable kerosenes increased the production of the less desirable naphthas. At times, the production of naphthas so far exceeded the demand that the refiners in some cases threw them away.

Various modifications of the Allen-Harris system were made for the utilization of this by-product oil, one of the latest consisting of a bench of vertical and horizontal retorts. The vertical retorts were filled with anthracite coal, while the horizontal retorts remained empty and were divided by means of a horizontal partition extending almost to the back of the retort. Superheated steam was admitted to the top of the vertical retorts, and decomposed during its travel down through the incandescent fuel; it then entered the lower chamber of the double horizontal retort, where oil was sprayed in by means of steam, and the mixture traversed the bottom section from front to back and the top section from back to front, leaving the standpipe and hydraulic main in the usual way. The fixing of the oil vapors took place in the double retort, the object of the horizontal partition being to lengthen the travel of the gases over the heated surface.

The Salisbury, or Slade, process was probably the last of many attempts to produce water gas in coal gas benches. In this system, superheated steam and naphtha were introduced into the front of one retort, passed to the back, and thence, by means of a fireclay connection, to the rear of a second retort containing a charge of anthracite coal. In flowing through the coal, the steam was decomposed and the oil vapors fixed, the finished gas leaving the front of the top retort.

A study of the heat requirements for coal and water gas production may be of interest, in showing why the manufacture of water gas by the retort process was abandoned in favor of the generator process. A modern coal gas bench requires the combustion of about 280 pounds of coke, or the generation of about 3,500,000 B. T. U., to carbonize 1 ton of coal and produce 11,000 cubic feet of gas; about 320 B. T. U. per cubic foot of gas. Euchene has calculated that the heat absorbed by the endothermic reactions occurring in the formation of coal gas is slightly less than that given off by the exothermic reactions; from which we seem warranted in saying that if gas coal were heated to the proper temperature, distillation would proceed without further addition

of heat. This being so, it would seem that only as much heat flows through the walls of a coal gas retort as is carried away as sensible heat by the illuminating gas and by the coke. This amounts approximately to 140 B. T. U. per cubic foot of gas, and under these conditions, the efficiency of heat utilization is about 44%.

In the water gas reaction—

$$C + H_2O = CO + H_2$$

there is absorbed 4,340 B. T. U. per pound of carbon, or about 70 B. T. U. per cubic foot of gas. The production of 1,000 cubic feet of commercial blue water gas will require from 40 to 45 pounds of steam, of which roughly only half is decomposed; the remainder passes unaltered through the fire; the carbon entering into the formation of CO and CO_2 will amount approximately to 15 pounds, or say 17 pounds of fuel; to heat this steam and fuel to a gas making temperature of 2,300° F., will require approximately 60 B. T. U. per cubic foot of gas; making the total heat absorbed 130 B. T. U. per cubic foot. Where the steam was superheated by waste gases, as was the practice in many cases, the total heat transmitted through the retort walls should be less per cubic foot of water gas produced, than per cubic foot of coal gas; and the consequent consumption of bench fuel should be less were it not for the differences in the temperature requirements of the two processes.

While the decomposition of steam in the presence of carbon is practically completed at a temperature of 2,000° F., it is true only when the flow is exceedingly slow or the time of contact very long.

Commercially, it seems necessary in the modern type of apparatus to carry fuel bed temperatures above 2,500° F.; and even in the old retort processes it was probably necessary to maintain an average temperature of over 2,000° F. In coal carbonization the production of gas begins at a relatively low temperature, and it is probable that the average temperature of the charge is not over 1,300° F.

Since the maximum temperature to which it is practicable to subject a fireclay retort is not over 2,400° F., it would seem that the average heat head for water gas production would probably be not over 400° (2,400° − 2,000°), compared with 1,100° (2,400° − 1,300°) in coal gas production. It is evident that for the same heat transfer it would be necessary in retort practice to burn more bench fuel per cubic foot of water gas produced than per cubic foot of coal gas.

No reliable figures are available regarding the actual fuel consumed per M of blue water gas in the retort processes, but the published results indicate from 50 to 60 pounds of bench fuel, plus 17 pounds of fuel carried off by the gas as CO and CO_2, or a total consumption of not less than 75 pounds. In a modern generator-type apparatus, blue gas can be produced with a fuel consumption of less than half of this. As would also be expected, the water gas produced in the retort processes contained a higher percentage of CO_2 (probably about 10%), most of which, however, was removed by lime purification. In addition to the excessive fuel consumption, it is probable that since there was no carbon deposited on the water gas retorts, they were very porous, and leaked either gas or air; this deposition of carbon in coal gas retorts is of considerable assistance in reducing leakage through the otherwise porous material.

Generator-Retort Systems.

In an attempt to overcome the objections mentioned, the next step was the generator-retort system, in which non-luminous water gas was made from carbon heated by internal combustion, and later carbureted. Probably the most successful example of this type of apparatus were the Tessie du Motay and the Wilkinson; the same in principle but differing in details of construction.

Blue gas was made intermittently in a double generator and stored in a "hydrogen" holder, from which it was drawn by an exhauster and passed through a steam heated evaporator, or illuminator," where it picked up naphtha vapors. The water gas enriched by naphtha vapors and carrying them in suspension, was then sent through externally heated retorts, where the mixture was "roasted," or made into a permanent gas. In some cases this plan was abandoned on account of the difficulty of obtaining naphtha, and crude oil was introduced into the retorts.

The Wilkinson apparatus had provision for making up-and-down runs on the generators, probably the first apparatus to be provided with this feature.

Many modifications of these principles were brought out. In the Hanlon-Johnson, the water gas and oil gas were made and stored in separate holders and mixed cold.

In the Edgerton, the oil gas was produced in vertical retorts heated by the blast gases from the water gas fires; probably the first attempt to generate the total required heat in one fuel bed. The oil gas and the blue gas were metered separately and mixed cold.

The Mackenzie and the Egner types were similar in principle, though different in form. In both an attempt was made to secure a continuous production of gas, by carbureting producer gas with oil in a coal gas retort. The excessive quantity of nitrogen undoubtedly was one of the main causes for discarding the process, since 1% of nitrogen added to a 22-candle power (flat flame) water gas will decrease its candle power about 3%.

The fundamental objections to the generator retort processes are as follows:

1. With the exception of the Edgerton apparatus, they require two fuel beds. In present day apparatus the fires are so regulated that the sensible and latent combustion heat in the blast gases leaving the generator furnish enough heat to vaporize and fix the oil; so that nearly all of the additional fuel burned in the benches for fixing the gas represented waste.
2. A two step process is, in general, less desirable, and more expensive than a single step process.
3. The capacity for a given ground area was small.
4. The fixing surface was small for a given volume of apparatus.
5. Experiments by Hempel, and by the writer, upon the effect of vaporizing oil in the presence of blue gas, prove that chemical action takes place between the hydrogen of the gas and the hydrocarbons of the oil, showing the advantages of vaporizing and fixing the oil in the presence of blue gas. It is possible that in the Tessie du Motay type, in which the oil is not subjected to high temperature until mixed with blue gas, no evil effects would result. However, in these processes in which the finished oil gas is finally mixed with the blue gas, such as the Hanlon-Johnson and the Edgerton, this objection would apply. The processes that possessed the advantages of mixing blue gas and oil vapor before fixing seem to have been restricted to the use of naphtha. This, because of the high cost of naphtha, would prohibit their use to-day.

Lowe System.

The basis of the modern water gas apparatus was invented by Prof. T. S. C. Lowe, of Norristown, Pa., who, during the Civil War, was engaged in the manufacture of gas for balloons. In 1875 he took out a patent covering a separate fixing chamber heated by internal combustion, thus laying the foundation for the types of apparatus now in use.

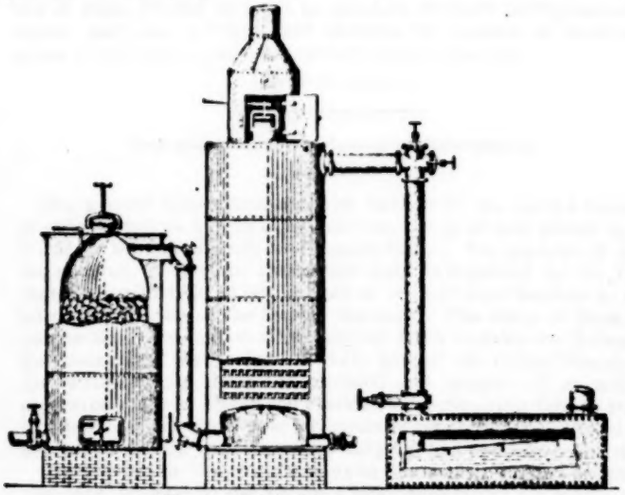


Fig. 2.—Original Lowe Apparatus.

The original Lowe apparatus is shown in Fig. 2. The fire was blown by forced draft, and the superheater heated by secondary combustion. During the run, oil was sprayed on top of the fire. In the patent, provision was made for passing the illuminating gas through a boiler which furnished steam to the generator; the products of combustion leaving the stack, were discharged through an air heater, which preheated both the primary and secondary air.

At least one works of large size has until recently followed the practice of admitting some of the oil on top of the fire, thereby obtaining an increase in candles per gallon. The reason for discontinuing this was the extreme care required to obtain results.

In view of the development of the waste heat boiler of the present day, it is interesting to note that Prof. Lowe showed sep-

arate devices for recovering heat from the illuminating and from the blast gases. His patent application also provides for the use of superheated steam. Although no records are available showing that superheated steam was used in those days, it is of interest to see that its use at present is looked upon with favor. Prof. Lowe laid particular stress upon the importance of vaporizing the oil in the presence of hydrogen, and while the precise chemical reactions may not have been known, he specifies that a beneficial effect is obtained.

The great advances in the art made by Prof. Lowe seem to be:

1. The reduction of fuel consumption, by the utilization of previously wasted gases from the generator for the internal heating of a fixing vessel.
2. The statement of the advantages to be derived by vaporization of oil in the presence of hydrogen.
3. The design of an apparatus that could be used with an easily volatile oil like naphtha, or with the less volatile gas oil of the present day.

The introduction of the Lowe apparatus in 1874, at Phoenixville, Pa., was followed by numerous designs bearing other names, but all based upon the Lowe principle.

In the Granger-Collins type, the long goose-neck connection between the generator and the superheater was eliminated by locating the generator in the cellar and having the shells slightly lapping, giving a short, straight horizontal connection from the top of the generator to the base of the superheater. This design decreased the heat lost, brought all the valves in a convenient location for easy operation, reduced the ground area required, and allowed of fairly free access to the fire for cleaning.

In the Hanlon-Leadley there were three generators, connected to two steam and two gas superheaters. The generators were blown in parallel, which made possible the use of a shallow bed for blasting, with consequent decrease in resistance. During the run, the steam passed through the superheaters, and then through the generator in series, thereby getting the effect of a deep fuel bed for the decomposition of the steam. The mixture of oil vapor and water gas was fixed by passing through the two gas superheaters in parallel. The germ of the idea is found in the double generator of the present day. The chief objection to the early machines was the difficulty of keeping both gas superheaters at the same temperature.

In the Springer set the superheater was placed above the generator, thereby reducing the ground area, but correspondingly increasing the height of the apparatus. The chief objection to this type is in the difficulty of access to the fire for cleaning.

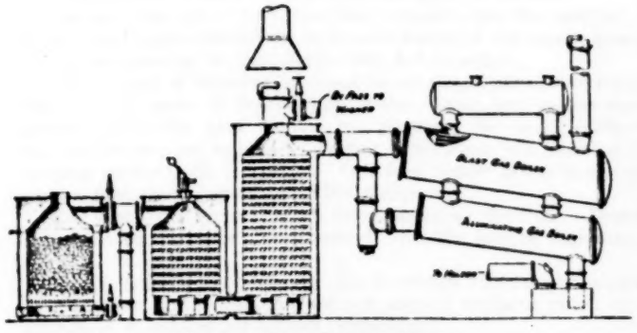


Fig. 3.—Modern Lowe Apparatus.

One of the first improvements in the original Lowe design was brought about by the necessity of using heavier oils. It consisted in enlarging the goose-neck connection between the generator and superheater to form another superheater known, as the "first" superheater. Later, the second superheater was made higher to increase the fixing surface, and to act as a short stack for producing a draft, thus carrying away the heated gases, which otherwise might issue from the generator fuel-charging-door during coaling. The placing of the stack valve well above the operating floor also removed the possibility of injury to the gas maker from flames issuing from it. The height of the entire apparatus was increased to allow a deeper fuel bed. In 1891 the up-and-down run feature was added; since that time changes in design have been less radical, although each improvement has increased the efficiency, the capacity, the flexibility, or the safety of the apparatus. One modern form of setting, equipped with double waste-heat boiler, is shown in Fig. 3.

Systems Using Bituminous Coal.

Due to the difference in cost between anthracite coal and coke, and bituminous coal, particularly in the West, many attempts have been made to use soft coal in water gas generators. Although the use of soft coal in producers is common, the requirements for water gas production are so much more exacting that it cannot yet be said to be entirely successful.

Some of the differences in requirements of the two methods of gas generation are these:

1. While the fuel consumption in a producer is about 12 pounds per square foot per hour, in modern water gas sets it may be as much as 80 pounds.
2. On account of the delecterious effect of impurities, such as CO_2, upon candle power, the water gas reaction must be more sharply defined in generators than in producers, and in consequence, the temperatures carried must be higher.
3. The action in a producer is continuous, the coal gradually increasing in temperature in its descent in the fuel bed, and it is not subjected to the full steam until it reaches the base of the fire. In water gas sets, because of the down runs, the coal on the top of the fire is subjected to great variations in temperature, tending to disintegrate the lumps, and to cause the particles to fuse together, thus impeding blast, decreasing capacity, and producing the injurious results of channelling.

Since the successful use of bituminous coal in water gas generators is so desirable, it may be of interest to describe some of the difficulties met with in its use. Before the carbon in bituminous coal can be heated to the temperature required for water gas making, it is necessary to drive off most of the volatile matter, and any heat supplied to the coal is absorbed by this volatile matter, preventing any considerable rise in temperature. It is possible that the volatile matter driven off from a piece of soft coal forms a gaseous envelope that prevents the steam from coming in contact with the coal, or else by diluting the steam it retards its decomposition.

When bituminous coal is heated it melts to a greater or less extent, and forms a mass not readily permeable. In a water gas generator, this means a blanket on top of the fire, offering great resistance to blast. The consequence is that the grate pressure rises until a hole is blown through this blanket, when the air rushes through in one place, producing channeling. The high air velocity blows considerable fuel out of the generator into the succeeding apparatus; in some experiments as much as 10% of the fuel charged into the generator has been thus collected in the dust-trap at the generator outlet. To stop this by mechanically breaking holes in the blanket, is not only expensive, but produces such poor coke that the effect is much the same as when operating with breeze, and the cure is almost as bad as the disease.

The Fehnehjelm apparatus shown in Fig. 4, was one of the first designed for soft coal. In it there was an extension of the generator into the superheater above, forming a retort for the coking of the coal before it was discharged into the generator. An ordinary 6-foot water gas set will consume about 10 tons of fuel per 24 hours. To supply this quantity of coke in ordinary coal gas manufacture would require the continuous use of about 18 stop-end retorts. While it is probable that for direct use in water gas manufacture the coal would not require as thorough carbonization as in coal gas apparatus, still the temperature available in a design like the Fahnehjelm is so much less than in ordinary retorts that the relation given above might well apply. It is evident that the small capacity of the upper retort for producing usable coke is the primary objection to this form of appartus.

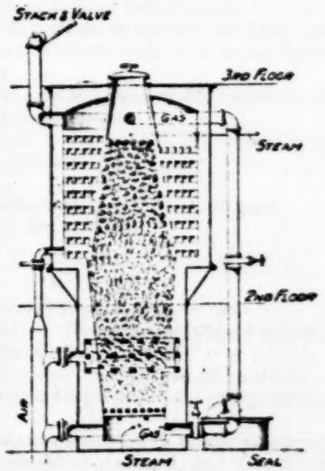


Fig. 4. Fahnehjelm Apparatus.

The Rose-Hastings apparatus was well advertised, and remarkable results were claimed. It was installed in several towns, but apparently no two installations were alike. One of the latest is shown in Fig. 5.

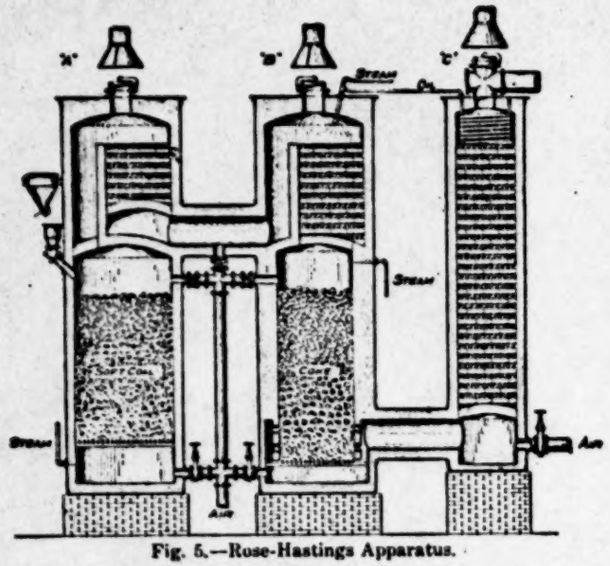


Fig. 5.—Rose-Hastings Apparatus.

Chamber *A* is the generator proper; charged with soft coal about once an hour, making a bed about 8-feet deep. Chamber *B* was filled with oven coke. In blasting, the stack valve of *A* was opened, *B* and *C* being closed; air was admitted below the grates of *A* and *B*, secondary air being admitted above the fires and to the connection between the shells. In about 5 minutes stack valve *B* was opened, and *A* closed; about 2 minutes later stack valve *C* was opened and *A* and *B* closed, additional secondary air being admitted to the base of *C* as required. By this means the two fires and the checkerbrick were brought up to the proper heat. During the run, steam was admitted below the grate of the soft coal fire in *A*, and the water gas and some coal gas with it passed up and through the checkerbrick of *A*, to the top of the checkers in *B*, where it met the oil sprayed in by steam. The vapors then passed down through the checkers and through the coke fire in the superheater *C*. Steam was not admitted to the coke fire except when it became too hot.

The object of the coke fire was to fix the oil vapors, and to improve the quality of the blue water gas made in the soft coal fire by converting the abnormally high content of CO_2 into CO. It would seem, however, that temperature sufficient to bring about this reaction would overheat the oil. Moreover, since there must have been considerable excess steam in the gases leaving the soft coal fire, probably some of the steam was decomposed into a poor quality water gas having a high content of CO_2, and the passage of the gas through the coke fire increased rather than decreased the CO_2 present. The candle power of the gas was very uncertain, as should be expected from the method (passage through hot fire) adopted for the gasification of the oil.

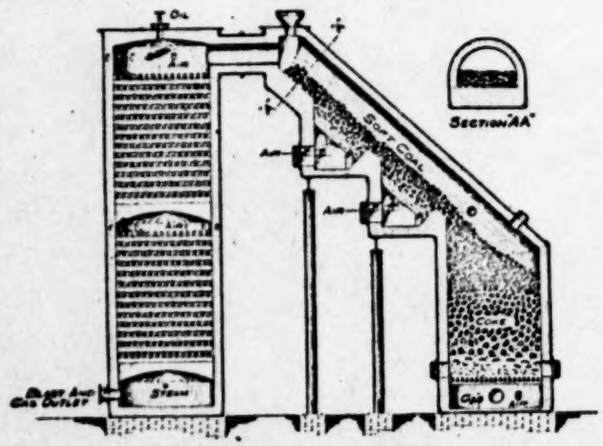


Fig. 6.—Rew Soft Coal Apparatus.

The Rew apparatus, Fig. 6, was built in pairs, and the operation was as follows:

Blast was admitted below the grates of both generators, passed over the bed of coal lying in the coking chamber and down through the regenerators. Additional primary air was admitted below the grates in the coking chamber, and secondary air to the top of the generators and to the regenerators. During the run, steam entered the base of one regenerator, where it was superheated, and traveled up and down over the bed of uncoked coal, picking up the hydrocarbons that might have been distilled; then continued down through the fire in the first generator and up through the fire in the second. From the second generator it passed over the second bed of coal, picking up more coal gas. Oil was admitted at the top of the second regenerator, and the finally fixed mixture of gases was led off from the base of the regenerator. In the succeeding run the direction of flow was reversed.

No coke was used once the apparatus had been brought up to gas making conditions, all the fuel being soft coal fed into the top of the coking chambers.

While it was thought that ample provision had been made for coking the coal by the internal combustion through air admitted below the secondary grates, by the alternate passage of products of combustion and the heated steam and gases over the coking bed, and by the radiant heat from the brick lining, it was found that there was not sufficient coke produced to supply the generator, and that produced was spongy and easily broken, and poor for water gas making. Also, the coal would stick upon the incline and required continuous poking to make it move down. These features, together with the fact that the design of apparatus made the labor required to operate it great, forced it to give away to other types, which, although using a more expensive fuel, produced a cheaper gas.

In the Loomis apparatus the grate was of firebrick. Air for combustion was drawn, by a exhauster, down through the fire, and thence through a superheater consisting of a vesel containing vertical flues. To cool the gases they were then passed through a boiler. Oil was admitted to the set at the outlet of the generator. As usually built, there were two generators, blown in parallel and run in series, the oil being sprayed on top of the fire, and passing through one fire. Provision was made for making up and down runs. While several plants were installed, they were eventually abandoned, and the process to-day is restricted to the manufacture of producer gas.

Probably the most successful use of soft coal in carbureted water gas practice was attained by Mr. G. W. Wallace, at East St. Louis. By very careful experiments and study, he has been able to use a lump coal of a particular kind, possessing somewhat the characteristics of wood, in that it tends to maintain its form during carbonization, and does not melt and obstruct the passage of blast and steam to the same extent as ordinary bituminous coal.

(To be Continued.)

Geological Survey a Bureau of Information.

The general recognition that the Geological Survey is a bureau of information as well as a field service, has gradually placed upon it a large burden of work and responsibility. The amount of correspondence involved in this public duty is indicated by the fact that approximately 50,000 letters of inquiry were handled in the scientific branches of the Survey last year. The scope of these inquiries is not less noteworthy, ranging from requests for information concerning the geology of every part of the United States, or the water supply, both underground and surface, of as widely separated points as Alaska and Florida; or engineering data on areas in every State in the Union, to inquiries regarding the natural resources of foreign countries, especially Central and South America.

The changes in the world's trade in metals and mineral products last year, brought to the Survey a new opportunity for special service. Inquiries concerning possible sources of this or that mineral began early in August, and the Secretary of the Interior gave to the public an interview outlining the expected developments in the mineral industry. His statement was followed by special press bulletins from the Survey on the more important subjects. In September, 1914, the demand for authoritative information had become so lively that a bulletin—"Our Mineral Reserves" (Bulletin 599)—was prepared and issued. In this publication the whole subject of the country's ability to meet the emergency demands for minerals was summarized, and the Survey offered to serve as an agent in bringing consumer and producer into touch. This new function proved popular, a large volume of special correspondence developed, and a gratifying use was make of the Geological Survey's list of mineral producers, and of the specific information of the Federal geologists regarding practically every type of mineral deposit in the country.

REPORT OF THE COMMITTEE ON NOMENCLATURE AND STANDARDS OF THE ILLUMINATING ENGINEERING SOCIETY.

DEFINITIONS.

Luminous flux is radiant power evaluated according to its capacity to produce the sensation of light.

The stimulus coefficient K_λ for radiation of a particular wave length, is the ratio of the luminous flux to the radiant power producing it.

The mean value of the stimulus coefficient, K_m, over any range of wave-lengths, or for the whole visible spectrum of any source, is the ratio of the total luminous flux (in lumens) to the total radiant power (in ergs per second, but more commonly in watts).

The luminous intensity of a point source of light, is the solid angular density of the luminous flux emitted by the source in the direction considered; or it is the flux per unit solid angle from that source.

Defining equation:

Let I be the intensity for the flux, and ω the solid angle.

Then $$I = \frac{dF}{d\omega};$$

or, if the intensity is uniform,

$$I = \frac{F}{\omega}.$$

Illumination, on a surface, is the luminous flux-density over that surface, or the flux per unit of intercepting area.

Defining equation:

Let E be the illumination, and S the area of the intercepting surface.

Then $$E = \frac{dF}{dS};$$

or, when uniform,

$$E = \frac{F}{S}.$$

Candle—the unit of luminous intensity maintained by the national laboratories of France, Great Britain and the United States. (Sometimes called the "International Candle.)

Candlepower—luminous intensity expressed in candles.

Lumen—the unit of luminous flux; equal to the flux emitted in a unit solid angle (steradian) by a point source of one candle power. (A uniform source of one candle emits 4π lumens.)

Lux—a unit of illumination equal to one lumen per square meter. The C. G. S. unit of illumination is one lumen per square centimeter. For this unit Blondel has proposed the name "Phot." One millilumen per square centimeter (milliphot) is a practical derivative of the C. G. S. system. One foot candle is one lumen per square foot, and is equal to 1.0764 milliphots.

Exposure—the product of an illumination by the time. Blondel has proposed the name "phot-second" for the unit of exposure in the C. G. S. system.

Specific luminous radiation—the luminous flux-density emitted by a surface, or the flux emitted per unit of emissive area. It is expressed in lumens per square centimeter.

Defining equation:

Let E′ be the specific luminous radiation;

Then, for surfaces obeying Lambert's cosine law of emission,

$$E' = \pi b_0.$$

Brightness, b, of an element of a luminous surface from a given position, may be expressed in terms of the luminous intensity per unit area of the surface projected on a plane perpendicular to the line of sight, and including only a surface of dimensions negligibly small in comparison with the distance of the observer. It is measured in candles per square centimeter of the projected area.

Defining equation:

Let θ be the angle between the normal to the surface and the line of sight;

Then

$$b = \frac{dI}{dS \cos\theta}.$$

Normal brightness, b_0, of an element of a surface (sometimes called specific luminous intensity) is the brightness taken in a direction normal to the surface. (In practice, the brightnes b of a luminous surface or element thereof is observed, and not the normal brightness b_0. For surfaces for which the cosine law of emission holds, the quantities b and b_0 are equal).

Defining equation:

$$b_0 = \frac{dI}{dS};$$

or, when uniform, $$b_0 = \frac{I}{S}$$

Brightness may also be expressed in terms of the specific luminous radiation of an ideal surface of perfect diffusing qualities, *i. e.*, one obeying Lambert's cosine law.

Lambert—the C. G, S. unit of brightness—the brightness of a perfectly diffusing surface, radiating or reflecting one lumen per square centimeter. This is equivalent to the brightness of a perfectly diffusing surface having a coefficient of reflection equal to unity, and illuminated by one phot. For most purposes, the millilambert (0.001 lambert) is the preferable practical unit.

A perfectly diffusing surface emitting one lumen per square foot will have a brightness of 1.076 millilamberts.

Brightness expressed in candles per square centimeter may be reduced to lamberts by multiplying by π (= 3.14).

Brightness expressed in candles per square inch may be reduced to foot-candle brightness by multiplying by the factor 144π (=452).

Brightness expressed in candles per square inch may be reduced to lamberts by multiplying by π 6.45 (= 0.4868).

In practice, no surface obeys exactly Lambert's cosine law of emission; hence the brightness of a surface in Lamberts is, in general, not numerically equal to its specific luminous radiation in lumens per square centimeter.

Defiining equations:

$$L = \frac{dF}{dS};$$

or, when uniform, $$L = \frac{F}{S}.$$

Coefficient of reflection—the ratio of the total luminous flux reflected by a surface, to the total luminous flux incident upon it. It is a simple numeric. The reflection from a surface may be regular, diffused or mixed. In perfect regular reflection, all of the flux is reflected from the surface at an angle of reflection equal to the angle of incidence. In perfect diffuse reflection the flux is reflected from the surface in all directions, in accordance with Lambert's cosine law. In most practical cases there is a superposition of regular and diffuse reflection.

Coefficient of regular reflection, is the ratio of the luminous flux reflected regularly, to the total incident flux.

Coefficient of diffuse reflection, is the ratio of the luminous flux reflected diffusely, to the total incident flux.

Defining equation:

Let m be the coefficient of reflection (regular or diffuse);

Then for any given portion of the surface,

$$m = \frac{E'}{E}.$$

Lamp—a generic term for an artificial source of light.

Primary luminous standard—a recognized standard luminous source reproducible from specifications.

Representative luminous standard—a standard of luminous intensity adopted as the authoritative custodian of the accepted value of the unit.

Reference standard—a standard calibrated in terms of the unit, from either a primary or representative standard, and used for the calibration of working standards.

Working Standard—any standardized luminous source for daily use in photometry.

Comparison lamp—a lamp of constant but not necessarily known candlepower, against which a working standard and test lamps are successively compared in a photometer.

Test lamp, in a photometer—a lamp to be tested.

Performance curve—a curve representing the behavior of a lamp in any particular (candle power, consumption, etc) at different periods during its life.

(*Continued on page 58.*)

Telephone • John, 2996.

THE AMERICAN GAS LIGHT JOURNAL

Cable, • Am-Gas.

Entered at the Post Office, New York City, as Second-Class Matter.

Published Weekly at 42 Pine Street, New York City.

SANFORD K. CAMPBELL, Editor.

E. P. CALLENDER, Pres. and Treas.
F. A. SOUTHWORTH, Vice-Pres.

CHARLES H. WADELTON,
Secretary and Manager.

NEW YORK, MONDAY, JANUARY 24, 1916.

Gas Heating Engineers.

Probably the next step towards specialization in the commercial field will be the recognition of Gas Heating Engineers, with lines of work as distinctive and at least as important as those of Illuminating Engineers and Industrial Gas Engineers. We are in just as good a position to get the heating business to-day, as we were to get the cooking business 20 years ago. The utilization efficiency of gas heaters is as high as that of gas cooking appliances, but here the comparison must stop, as the commercial aspect is entirely different.

Even 15 years ago the woman knew what she wanted in the kitchen, and when she did not know how to use the gas range she soon learned. It was her pleasure, as well as her business, to use the gas stove with economy and satisfaction.

Heating has been everybody's business, with the usual success that such care entails. As far as homes are concerned, the man begins the day with sundry shakings, pokings and fillings of the furnace, which his wife dutifully follows in like manner. Either that, or a furnace man comes with about the same regularity and success that the janitor evidences in caring for the appartment heating system.

The time is now at hand when gas can be substituted for other fuels with economy as well as comfort, on a much broader scale and in much greater volume than is at present obtained.

The installation of gas fired steam radiators, described in other columns, indicate one of the fields now ready. This particular appliance makes no great claims for efficiency, but it looks like another kind of heater that people are used to having, and can be substituted therefor in many instances.

These, and many other kinds of prospects for heating appliances, are waiting for the gas salesman, who has the knowledge of heating which will enable him to sell the right appliance in the right place. We hope to see the work become of sufficient size, and it is already of enough importance, to warrant the use of the title, Gas Heating Engineer.

Ventilate by Gas Lights.

A Southern correspondent calls our attention to an article in the "American Magazine," in which a Congressman says:

"I desire to get out of Congress for purely hygienic reasons. The House of Representatives is a poorly ventilated hall in which the faithful member is obliged to sit for several hours a day and breathe the exhalations from a few hundred other human beings. There are no windows in the House, it being entirely surrounded, both on the main and gallery floors, by corridors. About the only fresh air available comes in by artificial means through little openings in the floor, and the foul air has to get out the best it can through the skylight. It has always seemed to me that the foul air never gets out at all; at any rate I seldom enter the floor of the House that the air does not seem a little more stuffy than it was the day before. Moreover, it is a superheated air. In the winter time the temperature in the House is kept, I believe, at from 74° to 76°. Over in the Senate it is 2° or 3° higher, because of the greater percentage of elderly men who desire to be in a thoroughly warm room."

Our friend adds: "Isn't it a pity that we can't get an air-ship big enough to take every blessed Congressman to London for a day and show them how the British ventilate their Legislative Halls by means of GAS LIGHT."

As an indication of the deep thought given the question of ventilation of the House of Representatives, we recall seeing, in 1900, government chemists taking samples of the air there, at different heights above the floor, at a time when the House was not in session! Their idea must have been to provide sufficient fresh air when there was no one there.

I. E. S. Council Meeting.

At the meeting of the Council of the Illuminating Engineering Society, held January 13, 1916, at the general offices of the Society, 29 West 39th street, New York, the detailed plans for the mid-winter convention to be held February 10 and 11, 1916, were outlined. Reports on section activities were given by J. L. Minick, vice-president of the Pittsburgh Section; Prof. Geo. A. Hoadley, vice-president of the Philadelphia Section; Clarence A. Law, vice-president of the New York Section; W. A. Durgin reported for the Chicago Section, and Dr. Louis Bell for the New England Section. All these reports indicated that the sections will have a very successful year in the point of papers, attendance, etc.

Dr. E. P. Hyde, chairman of the Committee on Lectures, presented a report outlining the plans for the series of lectures on illuminating engineering to be given in the fall of 1916 at one of the eastern universities.

The following committee appointments were confirmed:

Committee on Education—F. K. Richtmyer, chairman.

Sub-Committee on Industrial Lighting of the Committee on Popular Lectures—H. H. Magdsick, Geo. A. Halvorson.

Committee on Ways and Means, of the lecture course—J. D. Israel, A. S. McAllister, W. J. Serrill, C. H. Stickney.

Committee on Editing and Publication—A. S. McAllister.

Fourteen applicants were transferred from the grade of associate member to that of member. One applicant was elected an associate member.

A report was received from the Board of Examiners, giving proposed changes in the by-laws.

Those present were: E. M. Alger, Louis Bell, C. O. Bond, W. A. Durgin, Geo. A. Hoadley, E. P. Hyde, Clarence L. Law, C. A. Littlefield, general secretary; M. Luckiesh, A. S. McAllister, L. B. Marks, treasurer; Preston B. Millar, J. L. Minick, J. A. Norcross.

New Jersey N. C. G. A. Meeting.

Mr. Jansen Haines, President of the National Commercial Gas Association, was the guest of honor of the Public Service Section of the National Commercial Gas Association, at Newark, Wednesday evening, January 19, at the Auditorium of the Public Service Gas Company.

The Chairman, Mr. J. P. Zingg, of Orange, assisted by Mr. W. M. Halsey, of Newark, had charge of the meeting. The first speaker, Mr. R. R. Young, New Business Agent, told in detail of the results of the years' Commercial Work. He was followed by Mr. J. P. Hanlan, New Business Assistant to the Agent, and outlined the plans for 1916.

Mr. P. S. Young, treasurer, spoke on "Organizations and the Efficiency of the Man."

Mr. W. H. Pettes, general auditor, outlined the work of the accountant.

Mr. Jansen Haines told of a visit to Newark some twenty years ago, and of the changes in and out of the business during these years.

During the evening there was music by the Public Service Band, assisted by soloists.

The election for 1916 resulted as follows;

Chairman—H. D. Gillingham, Newark.
Vice-Chairman—R. I. Wilson, Paterson.
Secretary—Norman Benz, Hackensack.

The attendance at this meeting will mark a record which the new officers will find hard to equal, as there were standing room only signs when the last of the 450 members present arrived.

[OFFICIAL NOTICES.]

Illuminating Engineering Society.

OFFICE OF THE CONVENTION COMMITTEE,
Irving Place and Fifteenth Street,
New York City, January 15, 1916.

The Mid-Winter Convention of the Society will be held in New York City, at the Engineering Societies Building, Thurday and Friday, February 10th and 11th, 1916. At this time the Society celebrates the decennial of its existence.

The list of the papers to be presented shows a wide range of subjects. There will be a review and record of what has been accomplished in the art and science of illuminating engineering, and it is hoped that the discussion will bring out plans for the future advance of the art. From this discussion the Society expects a year of greater activity than ever before in all the fields covered.

PAPERS PROGRAM.

"Relation of Lighting to Architectural Interiors," Prof. Morgan Brooks.

"Candle Power Measurements of Series Gas Filled Incandescent Lamps," Ralph C. Robinson.

"Theatre Lighting," Bassett Jones.

"Illuminated Engineering Photographs," B. H. Norris.

"Lighting of the General Offices of the Consolidated Gas and the New York Edison Companies, Consolidated Gas Building, New York City," Thomas Scofield and Clarence L. Law.

"Gas Lighting of a Large Cathedral in Philadelphia," J. D. Lee.

"An Interlaboratory Photometric Comparison of Glass Screens and of Tungsten Lamps, Involving Color Differences," G. W. Middlekauff and J. F. Skogland.

"An 'Average Eye' for Heterochromatic Photometry, and a Comparison of a Flicker and an Equality-of-Brightness Photometer," E. C. Crittenden and F. K. Richtmyer.

"An Intergrating Sphere," E. B. Rosa and A. H. Taylor.

"The Box Photometer," Prof L. O. Grondahl.

Lecture—Illustrated lecture on the lighting of the Panama-Pacific Industrial Exposition, W. D'Arcy Ryan.

The feature of the Convention will be the acceptance of honorary membership in the Society by Mr. Thomas Alva Edison, who will receive this honor at a banquet to be tendered him at the Biltmore Hotel, on Thursday evening, February 10th, at 7:30. It is hoped that all delegates and their friends will be present at this time. An entertainment program is being arranged to immediately follow the banquet. Subscription to the banquet will be $5, and visiting out-of-town ladies to the Convention will be guests,

The Committee wishes to especially invite ladies to this Convention, and arrangements are being made for their entertainment. Among other features, a luncheon will be given at the Biltmore Hotel to the ladies on Thursday noon, when a special exhibition of ice skating will also be made, so that guests at the luncheon can take advantage of the skating.

On Friday afternoon a popular lecture will be given by W. D'Arcy Ryan, the designer of the lighting of the Panama Pacific Exposition, illustrated by colored transparencies, 24 x 36 feet, which will convey more fully to those who have not visited the exposition the wonderful lighting effects produced.

No provision has been made for a hotel or transportation committee, because the many hotels in New York afford a range in price and convenience that should suit all delegates. Any information with reference to transportation the Secretary of the Committee will be very glad to furnish upon request.

On Tuesday and Wednesday, February 8th and 9th, the American Institute of Electrical Engineers hold their Mid-Winter Convention at the Engineering Societies Building, and all members of our Society are invited to participate in their activities.

This season of the year is a very popular one in New York city, and it is the hope of the Committee that all members will take advantage of the two Conventions and spend a profitable and entertaining week in the city.

ARTHUR WILLIAMS,
Chairman Convention Committee.

Illinois Gas Association.

OFFICE OF THE SECRETARY,
OAK PARK, ILLS.

The Twelfth Annual Meeting of the Illinois Gas Association will be held in Chicago, March 22d and 23d, 1916. This will be the most instructive and interesting program ever had by a State Gas Association.

The papers will be divided into four classes: General, Manufacturing, Distribution and Commercial. Not all of the papers have been decided upon as yet, but the following are assured:

"Stores Accounting," by W. A. Sauer.
"Constructive Advertising," by J. W. Lansley.
"Functions of Trade Journals," by Milt Saul.
"Gratuitous Work," by A. L. Tossell.
"The Proper Use of Gas in the Home," by W. H. Forbes.
"Some Fundamentals Affecting the Utilization of Gas Oil in Carburetted Water Gas Manufacture," by R. C. Downing.
"Treating Waste Water in Gas Plants," by Paul Hansen.
"Tools, their Use and Maintenance," by P. M. Slocum.
"A Report of the Committee on Meter Shelves," by E. H. Negley.
"Some Investigations of Bunsen Gas Burner Design and Operation," by G. C. Carnahan.

We expect to have a paper on a recent coal gas installation, similar to last year's paper on the Decatur plant, also a paper on New Business, and others. We will have reports from the various committees—Public Relations, Rates, Affiliation, Gas Engineering, etc. The Entertainment Committee, as usual, will have something extra fine at the banquet.

In connection with the circular letter sent out August 20th, we wish to correct, as far as possible, the inference that many gained, that we were interested in one particular Journal. Neither the Illinois Gas Association, nor its officers, wish to influence any of the members to become subscribers to any one particular journal, as they all deserve your encouragement and support. In the early days of the Association the Gas Journals contributed in many ways to help the struggling societies, and they now deserve your earnest support. We desire to call the attention of the members to the number of valuable articles published in the trade journals and periodicals, and urge the members to become subscribers to, and read as many as possible.

It has been proposed that the Illinois Electric Association, the Illinois Electric Street Railways Association and the Illinois Gas Association, consolidate into one Utility Association, or hold a joint meeting. We would be pleased to receive suggestions from members on this subject.

HORACE H. CLARK, Secretary.

(Continued from page 55.)

Report of the Committee on Nomenclature and Standards of the Illuminating Engineering Society.

Characteristic curve—a curve expressing a relation between two variable properties of a luminous source, as candle power and volts, candle power and rate of fuel consumption, etc.

Horizontal distribution curve—a polar curve representing the luminous intensity of a lamp, or lighting unit, in a plane perpendicular to the axis of the unit, and with the unit at the origin.

Vertical distribution curve—a polar curve representing the luminous intensity of a lamp, or lighting unit, in a plane passing through the axis of the unit and with the unit at the origin. Unless otherwise specified, a vertical distribution curve is assumed to be an average vertical distribution curve, such as may in many cases be obtained by rotating the unit about its axis, and measuring the average intensities at the different elevations. It is recommended that in vertical distribution curves, angles of elevation shall be counted positively, from the nadir as zero, to the zenith as 180°. In the case of incandescent electric lamps, it is assumed that the vertical distribution curve is taken with the tip downward.

Mean horizontal candle power of a lamp—the average candle power in the horizontal plane passing through the luminous center of the lamp.

It is here assumed that the lamp (or other light source) is mounted in the usual manner, or, as in the case of an incandescent lamp, with its axis of symmetry vertical.

Mean spherical candle power of a lamp—the average candle power of a lamp in all directions in space. It is equal to the total luminous flux emitted by the lamp in lumens divided by 4π.

Mean hemispherical candle power of a lamp (upper or lower)—the average candle power of a lamp in the hemisphere considered. It is equal to the total luminous flux emitted by the lamp in that hemisphere divided by 2π.

Mean zonal candle power of a lamp—the average candle power of a lamp over the given zone. It is equal to the total luminous flux emitted by the lamp in that zone divided by the solid angle of the zone.

Spherical reduction factor of a lamp—the ratio of the mean spherical to the mean horizontal candle power of the lamp. (In the case of a uniform point-source, this factor would be unity, and for a straight cylindrical filament obeying the cosine law it would be $\pi/4$.)

Photometric tests in which the results are stated in candle power should be made at such a distance from the source of light that the latter may be regarded as practically a point. Where tests are made in the measurement of lamps with reflectors, the results should always be given as "apparent candle power" at the distance employed, which distance should always be specifically stated.

The output of all illuminants should be expressed in lumens.

Illuminants should be rated upon a lumen basis instead of a candle power basis.

The specific output of electric lamps should be stated in terms of lumens per watt, and the specific output of illuminants depending upon combustion should be stated in lumens per B. T. U. per hour. The use of the term "efficiency" in this connection should be discouraged.

When auxiliary devices are necessarily employed in circuit with a lamp, the input should be taken to include both that in the lamp and that in the auxiliary devices. For example, the watts lost in the ballast resistance of an arc lamp are properly chargeable to the lamp.

The specific consumption of an electric lamp is its watt consumption per lumen. "Watts per candle" is a term used commercially in connection with electric incandescent lamps, and denotes watts per mean horizontal candle power.

Life tests—Electric incandescent lamps of a given type may be assumed to operate under comparable conditions only when their lumens per watt consumed are the same. Life test results, in order to be compared, must be either conducted under, or reduced to, comparable conditions of operation.

In comparing different luminous sources, not only should their candle power be compared, but also their relative form, brightness, distribution of illumination and character of light.

Lamp Accessories.—A *reflector* is an appliance, the chief use of which is to redirect the luminous flux of a lamp in a desired direction or directions.

A *shade* is an appliance, the chief aim of which is to diminish or to interrupt the flux of a lamp in certain directions where such flux is not desirable. The function of a shade is commonly combined with that of a reflector.

A *globe* is an enclosing appliance of clear or diffusing material, the chief use of which is either to protect the lamp or to diffuse its light.

PHOTOMETRIC UNITS AND ABBREVIATIONS.

Photometric quantity.	Name of unit.	Abbreviations, symbols and defining equations.
1. Luminous flux	Lumen.	F. Ψ
2. Luminous intensity	Candle.	$I = \frac{dF}{d\omega}$; $\Gamma = \frac{d\Psi}{d\omega}$, cp.
3. Illumination	Phot, foot-candles, lux	$E = \frac{dF}{dS} = \frac{I}{r^2}\cos\theta,\beta$
4. Exposure	Phot-second	Et
5. Brightness	Apparent candles per sq. cm.	$b = \frac{dI}{dS\cos\theta}$
	Apparent candles per sq. in	
	Lambert	$L = \frac{dF}{dS}$
6. Normal brightness	Candles per sq. cm. / Candles per sq. in.	$b_n = \frac{dI}{dS}$
7. Specific luminous radiation	Lumens per sq. cm. / Lumens per sq. in.	$E' = \pi b_n, \beta'$
8. Co-efficient of reflection	—	$m = \frac{E'}{E}$
9. Mean spherical candle power		scp
10. Mean low hemispherical candle power		lcp
11. Mean upper hemispherical candle power		ucp
12. Mean zonal candle power		zcp

13. 1 lumen is emitted by 0.07958 spherical cp.
14. 1 spherical candle power emits 12.57 lumens.
15. 1 lux = 1 lumen incident per square meter = 0.0001 phot = 0.1 milliphot.
16. 1 phot = 1 lumen incident per sq. cm. = 10,000 lux = 1000 milliphot.
17. 1 milliphot = 0.001 phot = 0.929 foot-candle.
18. 1 foot-candle = 1 lumen incident per square foot = 1.076 milliphot 10.76 lux.
19. 1 lambert = 1 lumen emitted per square centimeter.*
20. 1 millilambert = 0.001 lambert.
21. 1 lumen, emitted, per square foot* = 1.076 millilambert.
22. 1 millilambert = 0.929 lumen, emitted, per square foot.*
23. 1 lambert = 0.3183 candle per sq. cm. = 2.054 candles per sq. in.
24. 1 candle per sq. cm. = 3.1416 lamberts.
25. 1 candle per sq. in. = 0.4868 lamberts = 486.8 millilamberts.

SYMBOLS.

In view of the fact that the symbols heretofore proposed by this committee conflict, in some cases, with symbols adopted for electric units by the International Electrotechnical Commission, it is proposed that where the possibility of any confusion exists in the use of electrical and photometrical symbols, an alternative system of symbols for photometrical quantities should be employed. These should be derived exclusively from the Greek alphabet, for instance:

Luminous intensity..... Γ
Luminous flux ..... Ψ
Illumination.. ..... β.

* Perfect diffusion assumed.

Gas for War Balloons.

In a recent issue of the "Journal für Gasbeleuchtung," Herr Dr. Sanders of Darmstadt, has an article on hydrogen production for military balloons.

The captive balloons used are of the type introduced by Parseval and Sigsfeld in 1893-97, a cylindrical balloon that sets at an incline against the wind like a kite. They contain 21,000 to 30,000 cubic feet of gas, and are anchored by wire rope wound on a windlass. Used at a height of about 2,600 feet, the observer can see with the naked eye, in clear weather, about 12 miles. To get the best service, the captive balloon must be filled and ready to ascend in the shortest possible time; and in this connection the question of the gas supply is important. In the early days, the only process for making hydrogen was by the action of dilute sulphuric acid on iron turnings. As sulphuric acid in war times was required for the manufacture of gun-powder, Coutelle took advantage of Lavoisier's observation that steam passed over incandescent iron yielded hydrogen, and designed a plant, consisting of retorts charged with iron turnings, and heated by wood fires, to make hydrogen for charging balloons. The production was, however, slow, the plant was not portable, and the retorts weak. Return was consequently made to the acid process, and the German balloon section in 1870 used a plant consisting of 75 wine casks—60 used as gas producers, 12 as washers for the gas, and 3 as driers. With this plant an observation balloon could be charged in 5 hours; but it was clumsy and not adapted to field requirements. In the war of 1870 the French constructed the first portable hydrogen producer, using iron and sulphuric acid. A recent modification of this is the Godard plant, in which a wagon carries two iron hydrogen producers, a washer, a drier, and a pump that feeds the producers with acid and the washer with cold water. The diluted acid is pumped up through the two producers charged with iron fillings; about 250 pounds of iron and 500 pounds of sulphuric acid being required to produce 1,000 cubic feet of hydrogen.

Compressed Gas.

In the eighties, a process for producing hydrogen from dry materials was worked out by Majert and Richter, based on the fact that a mixture of zinc dust and slaked lime gives off hydrogen when heated to redness. A portable apparatus on this principal was used by the Prussian balloon section. Two or three hours were required to fill a balloon, but the military authorities considered it necessary to fill one in less than half-an-hour. In order to achieve this, the manufacture of hydrogen on the spot was abandoned, and compressed hydrogen in steel cylinders was carried. This method was first used in 1885, by the English expedition to the Soudan, where two cylinders formed the load of a camel. The Italians employed this method in Abyssinia in 1887; and it has since been adopted by almost all armies The cylinders first used by the English were 7.9 feet in length, and weighed about 66 pounds for a volume of about 1.13 cubic feet, which under a pressure of 120 atmospheres yielded 140 cubic feet of gas. The cylinders now used in the German army have a volume of 1.27 cubic feet; and, at a pressure of from 130 to 150 atmospheres, contain about 177 cubic feet of gas. The wagons used for transport carry twenty cylinders, and twelve wagons are attached to a balloon section—thus providing for filling one captive balloon twice. They are able to fill a balloon ready for ascent in 15 or 20 minutes. Special motor and railway wagons are also provided for the transport of gas cylinders. The wagons used in the French army are four-wheelers carrying six cylinders each containing 880 cubic feet of gas.

Portable Generators.

Portable hydrogen producers have been retained in some armies for use in mountainous districts or at a distance from railways. The Russian army in the war with Japan used portable apparatus depending on the action of aluminum and caustic soda. The action is very vigorous, and much heat is developed, consequently, the process requires an ample supply of cooling water. About 343 pounds of materials are required to produce 1,000 cubic feet of hydrogen by this process. A similar process was used by Spain in the Morocco campaign; using silicon and a solution of caustic soda. The reaction takes place very vigorously at 176° to 194° F., which temperature is provided by the heat of solution of the caustic soda in water. By this process 125 pounds of material will make 1,000 cubic feet of hydrogen. The apparatus, which is very light, is now used extensively by the German, Austro-Hungarian, Italian and Spanish balloon companies. A similar process the "Silikol" has been adopted by the French—in which a ferro-silicon, containing a high percentage of silicon, is treated with a 35 to 40% solution of soda. The materials to produce 1,000 cubic feet of gas by this process weigh only 119 pounds.

These processes, however, require considerable quantities of cool water; and the French "Hydrogenite" process has been devised for use where little water is available. The material used is a mixture of finely ground ferro-silicon and soda-lime, which ignites easily, and, on exclusion of air, burns readily and develops a large quantity of hydrogen. The mixed material keeps for an unlimited length of time at ordinary temperatures—187 pounds yielding 1,000 cubic feet of hydrogen of a very high degree of purity. The generator is surrounded with a water jacket; the heat of the reaction evaporates the water, and towards the end of the reaction the steam produced is introduced into the generator, increasing the yield of gas and extinguishing the material.

Calcium hydride also has been used in France, under the name of "Hydrolith," for producing hydrogen. It is manufactured by passing hydrogen into molten calcium. The hydride is, therefore, in a sense a hydrogen accumulator, as the gas can be produced by any process, and stored in the metallic calcium for use at any time. It is evolved immediately the hydride is brought in contact with water. The excessive evolution of heat which takes place on the decomposition at first caused great difficulties, but were overcome by the French chemist, Jaubert. A portable hydrogen generator, constructed at the military balloon factory at Chalais-Meudon, gave the extraordinarily high output of 56,480 cubic feet of hydrogen per hour. With 20 tons of calcium hydride, this plant will give 692,000 cubic feet of hydrogen.

Maurichau-Beaupré recommended activated aluminium as a material for producing hydrogen; but it was activated by poisonous potassium cyanide and corrosive sublimate. The Griefheim-Elektron works has succeeded in producing aluminium of nearly equal productive capacity by the addition of about 1% of caustic soda and 1% of mercuric oxide. This preparation is less poisonous; and on interaction with water, 60 pounds will yield 1,000 cubic feet of gas.

Stationary Generators.

Fixed plants for the production of hydrogen must have a high output per hour. Numerous processes are employed. In the nineties, the electrolytic water-decomposition process was introduced, which yields a very pure gas, and requires little attention. An Oerlikon plant yields 1,000 cubic feet of hydrogen by the expenditure of 212 B. T. U. of current; and is used at the military airship station at Farnborough and by the Swedish and Russian navies, which have balloon ships provided with this plant, compressors, and steel cylinders, for coast defence purposes.

Utilization of Water Gas.

Coutelle's old process has been re-introduced in recent years. The International Hydrogen Company, of Berlin, employs this process—producing porous iron sponge by the reduction of pyrites residues by water gas. The sponge heated to about 1,470° F. is acted on by steam. The ferric oxide produced is again reduced to iron by water gas. At first, horizontal iron retorts were used, but the "B. A. M. A. G." Company, which absorbed the International Hydrogen Company, has recently employed vertical fire-brick retorts. To keep the iron at the temperature for the reaction, water gas is burned in the retorts at intervals, whereas with the older retorts the heating was external. The process is therefore divided into three periods—(1) heating up; (2) reducing; (3) gas producing. The hydrogen made contains only 1 to 2% of impurities' and 1,000 cubic feet cost about 85 cents. The older form of this process was, until recently, in use in the fortress at Cologne, where there was an installation of 5,650 cubic feet per hour productive capacity.

An improvement of this process is embodied in the apparatus constructed by Dr. Messerschmidt. He uses a vertical chamber lined with firebrick, from the top of which an iron cylinder is suspended, with a smaller iron cylinder resting on the bottom of the producer, passing up within the first cylinder. The annular space between the two cylinders is packed with iron ore, and the interior of the producer is filled with fire-brick chequer-work. The water gas, mixed with a limited proportion of air, is admitted at the bottom of the producer, and passing upwards through the middle cylinder, heats the chequer work in it. It then passes down through the iron oxide, reducing it to metallic iron, and heating it, and finally passes upwards through the outer space in the producer, where the unburned gas is consumed by a secondary supply of air. The exterior fire-brick chequer-work is thus raised to the reaction

temperature of 1,290° to 1,470° Fahr. The construction assures very uniform heating of the iron oxide, and utilizes the heat of the reducing gas. The heating and reduction process terminates in about 20 minutes, and steam is then introduced. For a few seconds it sweeps the heating gases from the producer, and then the production of hydrogen commences—the steam being introduced at the top in the outer part of the generator. It passed up through the incandescent iron, which decomposes it. The hydrogen formed travels through a hydraulic main and is cooled and purified in the usual way. The gas-making period lasts about ten minutes; and the heating-up and reduction of the iron oxide is then repeated. The plant is adapted either for continuous working or for intermittent use, as the producer can be heated up from the cold in a few hours. The only attention required is observing the temperature and changing the control levers. A water-gas plant of ordinary construction is a necessary accessory. Plants on the Messerschmidt system have been erected at the Zeppelin yard in Friedrichshafen, at the fortresses at Cologne and Königsberg, and in a number of airship stations. The gas produced contains 98.5% hydrogen, and the cost of manufacture is low.

Utilization of Oil Gas.

Another process, worked out by Rincker and Wolter, takes oil gas, which is led through a generator filled with incandescent coke, and is so thoroughly decomposed that the hydrocarbons are split up into carbon and hydrogen. This process was in use at Königsberg until a short time age; and the Russian balloon sections use this type of plant mounted on two railway cars. The first car carries two generators, a blower, and an oil tank with pumps; the second carring the purifying plant. The generators are blown hot by the air-blast; and then oil is injected, gasified and decomposed. The hydrogen formed is exhausted from the bottom of the generator, and contains 2 to 3% of carbonic oxide, which is removed by passing over heated soda lime. The plant produces 3,500 cubic feet of hydrogen per hour, from crude petroleum, or tar, benzol or benzoline. Two men are required to attend it, and the cost of manufacture is from 60 cents to $1 per 1,000 cubic feet.

In addition to the processes mentioned, there are others suitable for large stationary installations. Thus the silicon process of the Schuckert firm is used at the fortress of Mayence, by the Swiss, and for the Italian airships at Bracciano. These plants have a productive capacity of 10,000 cubic feet per hour. Almost all the French fortresses on the eastern frontier are provided with large hydrogen plants of Jaubert's "Silikol" process.

There are now large hydrogen plants at many chemical works, oil factories, ship-yards, and electric lamp works. All these plants could, in case of need, be used for producing gas for military purposes. At the Griesheim-Elektron works, near Frankfort-on-the-Maine, which has done a great deal in developing airship travel in Germany, large quantities of hydrogen are produced daily as a by-product in the electrolysis of potassium chloride and sodium chloride.

Continuous Determination of Calorific Value of Gases.

By F. B. Larkin, in Wisconsin Engineer.

The Junker's Calorimeter is commonly provided with thermometers graduated in degrees C., water measuring receptacles graduated in cubic centermeters, and a gas meter reading in cubic feet. Thus the B. T. U. in a volume of gas, measured in cubic feet, are given up to a quantity of water measured in cubic centimeters, and therefore weighed in grams, whose temperature is raised a number of degrees C. thereby.

In order to determine the B. T. U.'s per cubic foot of gas, it is necessary to reduce the temperature range of the cooling water in degrees C. to degrees F., and the water in cubic centimeters, or grams, to pounds. A single reduction factor for this purpose may be developed from the relation between the British thermal unit and the calorie, namely: one B. T. U. equals 252 colories. We may then write our equation:

$$\frac{\text{c.c. of water} \times \text{range in degrees C.}}{252 \times \text{cubic feet of gas.}} = \text{B. T. U. per cu. ft.}$$

From this it will be seen that if the water quantity is made $10 \times 252 = 2{,}520$ c.c., the B. T. U. given to the water by the gas in the corresponding time will be $10 \times$ range in degrees C., or the temperature range with the decimal point moved one place to the right; and the B. T. U.'s per cubic foot will be this quantity divided by the number of cubic feet of gas passing the meter.

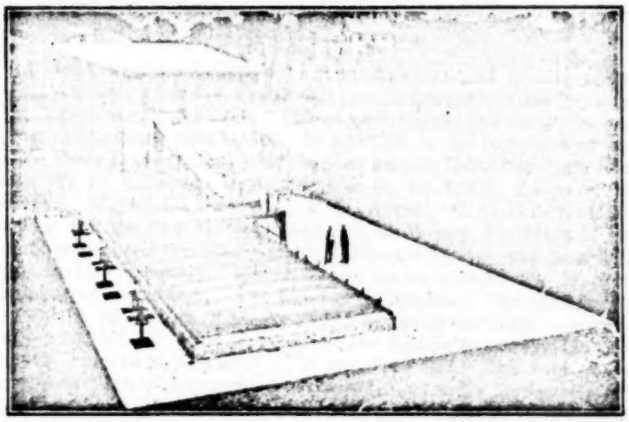
The following log, based on this reduction factor, makes it possible to secure continuous determinations of calorific value over periods of indefinite length. The table shows the results of a test of illuminating gas. A study of the table will show that the B. T. U. for the time necessary for 2,520 c.c. of water, to pass the calorimeter is obtained by moving the decimal point one place to the right; that the total B. T. U. in the gas burned at the end of any period is the average difference in temperatures of entering and leaving water with the decimal point moved one point to the right and multiplied by the number of periods; that the B. T. U. per cubic foot for the various periods will show the fluctuations in the calorific power of the gas; that the total B. T. U. per cubic foot was the calorific value of the gas from the beginning of the test; that the longer the test is continued the more nearly accurate the final value; and that the work may be checked from observation to observation to insure the absence of errors.

Test of Illuminating Gas.

Time.	Temperatures in Degrees C.						B. T. U.		Water Quantity.			Gas Meter			B.T.U. per Cu. Ft.		Pressures.		Condensation in C.C. of Water.
	Entering Gas.	Leaving Gas.	Entering Water.	Leaving Water.	Diff.	Av. Diff.	Period.	Total	Read.	Period.	Total.	Read.	Period.	Total.	Period.	Total.	At Flame in MM H2o	Barometer in Hg.	
9:52-10...	....	..	.....	.....	.....	.....	.....	.....	0	.....	.....	2.900	.....	.....	.....	.....	.....	.....	0
9:54-30...	29.2	..	22.17	33.12	10.95	10.950	109.5	109.5	..	2520	2520	3.083	.183	.183	598.3	589.3	12	29,953	..
9:56-40...	29.2	..	22.17	33.13	10.96	10.955	109.6	219.1	..	2520	5040	3.265	.182	.365	602.2	600.3	12	.....	..
9:58-45...	29.1	..	22.18	33.10	10.92	10.943	109.2	328.3	..	2520	7560	3.450	.185	.550	590.2	597.0	12	.....	..
10:1-1.....	29.1	..	22.17	33.10	10.93	10.940	109.3	437.6	..	2520	10080	3.633	.183	.733	597.3	597.0	12	.....	..
10:3-15....	29.2	..	22.15	33.10	10.95	10.942	109.5	547.1	..	2520	12600	3.816	.183	.916	598.3	597.2	12	.....	..
10:5-25....	28.2	..	22.15	33.10	10.95	10.943	109.5	656.6	..	2520	15120	3.997	.181	1.097	605.0	598.5	12	.....	..
10:7-40....	29.2	..	22.14	33.14	11.00	10.951	110.0	766.6	..	2520	17640	4.182	.185	1.282	594.0	598.0	12	.....	..
10:9-50....	29.3	..	22.13	33.08	10.95	10.951	109.5	876.1	..	2520	20160	4.336	.184	1.466	595.1	597.6	12	.....	..
10:12-5....	29.3	..	22.12	33.10	10.98	10.954	109.8	985.9	..	2520	22680	4.549	.183	1.649	600.0	597.9	12	.....	..
10:14-18...	29.3	..	22.11	33.10	10.99	10.958	109.9	1095.8	..	2520	25200	4.733	.184	1.833	597.3	597.8	12	.....	..
10:16-35...	29.3	..	22.11	33.08	10.97	10.959	109.7	1205.5	..	2520	27720	4.917	.184	2.017	596.2	597.7	12	.....	..
10:18-14...	29.3	..	22.10	33.03	10.93	10.957	109.3	1314.8	..	2520	30240	5.099	.182	2.199	600.5	597.9	12	.....	..
10:21-0....	29.3	..	22.11	33.09	10.98	10.958	109.8	1424.6	..	2520	32760	5.280	.181	2.380	606.6	598.5	12	.....	..
10:23-7....	29.3	..	22.14	33.12	10.98	10.960	109.8	1534.4	..	2520	35280	5.463	.183	2.563	600.0	598.7	12	.....	44
					153.44		1534.4												

New Methods and Appliances.

CONCRETE OUT-DOOR PURIFIERS.—An example of well designed out-door purifying boxes is this installation of three boxes at Arlington, Mass.



They were built for the Arlington Gas Light Company, by the Light, Heat and Power Corporation, which is the purchasing agent and contractor for the Massachusetts Lighting Companies.

LARGE AND SMALL UNITS ALIKE.—It seems remarkable as we look back over the years that gas has been in general use for the lighting of homes, stores and public buildings that nothing has ever been done until now to secure a balanced harmonious combination of big and little lighting units, that would suit the rising standards of interior decoration. A lighting fixture is, after all, a bit of furniture. In the home it is part of the furnishings, precisely as are the door knobs or the mantel-pieces. In the store it is part of the equipment, and no less a factor in the scheme of decoration than the type of show cases and shelves installed. As a matter of fact there is no feature of a building that is more conspicuously and continuously in sight than the lighting units.

In the development of gas lamps in the past, however, this has been little regarded, and though each manufacturer has endeavored to give his lamp a pleasing appearance, the engineering features have been ever foremost in his mind, and the influence that design exerts upon the market has received comparatively little attention.

Photograph of two Humphrey Units showing the harmony of design.

The development of the Humphrey Radio-Series of lighting units, by the General Gas Light Company, is a distinct contribution to the industry, in that it has brought out 3-mantle and single-mantle units in which design and size are carefully balanced, and harmonize with electric units available for use where the customer will not discard the electric installation. The accompanying cut shows the Radio-X and the Radio-30 units, photographed side by side to show relative size and identity in design. The commercial advantages of such a combination are apparent to every man who sells the product of the gas company. At last we have both large and small lamps sufficiently artistic to satisfy the exactions of handsome modern stores and public buildings.

HEATING SURFACE AND STEAMING CAPACITY.—Engineers seldom rate boilers in horse power, because there is no definite relation between it and the horse power of the engine it is capable of driving; and there is a tendency to force boilers to evaporate more water per square foot of heating surface. For these reasons it is preferable to speak of boilers in terms of their heating surface. In selecting boiler equipment engineers usually determine the rate of evaporation they can expect per unit heating surface with the fuel, draft and setting that is to be employed. The combined water rate of the steam consumers is then computed, and divided by the evaporative rate chosen, to obtain the total heating surface of the boilers required.

When manufacturers bid they often submit prices on equipment having widely different dimensions, and to compare horizontal tubular boilers directly both as to heating surface and horse power, the Hartford Steam Boiler Inspection & Insurance Company has prepared this table:

Diam. of Boiler Inches.	Tubes.			Heating Surface—Square Feet				Horse Power.
	Length Ft.	Diam., In.	No.	Tubes.	Shell.	Rear Head.	Total.	
54	14	3	54	552	99	8	650	66
54	16	3	54	631	113	8	752	75
54	14	3 1/2	44	526	99	8	633	63
54	16	3 1/2	44	601	113	8	722	72
54	14	4	34	467	99	8	574	57
54	16	4	34	534	113	8	655	65
60	16	3	72	841	125	10	976	98
60	18	3	72	946	141	10	1097	110
60	16	3 1/2	50	684	125	10	819	82
60	18	3 1/2	50	770	141	10	921	92
60	16	4	46	722	125	9	856	86
60	18	4	46	812	141	9	962	96
66	16	3	94	1098	138	11	1247	125
66	18	3	94	1235	156	11	1402	140
66	16	3 1/2	70	957	138	11	1106	110
66	18	3 1/2	70	1077	156	11	1244	124
66	16	4	56	878	138	11	1027	103
66	18	4	56	988	156	11	1155	115
72	16	3	118	1378	151	13	1542	154
72	18	3	118	1550	170	13	1733	173
72	20	3	118	1722	189	13	1924	192
72	16	3 1/2	94	1285	161	13	1449	145
72	18	3 1/2	94	1446	170	13	1629	163
72	20	3 1/2	94	1606	189	13	1808	181
72	16	4	70	1098	151	13	1262	126
72	18	4	70	1235	170	13	1418	142
72	20	4	70	1372	189	13	1574	157
78	16	3	140	1636	163	15	1813	181
78	18	3	140	1839	184	15	2038	204
78	20	3	140	2043	204	15	2262	226
78	16	3 1/2	108	1477	163	15	1655	165
78	18	3 1/2	108	1662	184	15	1861	186
78	20	3 1/2	108	1846	204	15	2065	206
78	16	4	88	1380	163	14	1557	156
78	18	4	88	1553	184	14	1751	175
78	20	4	88	1725	204	14	1943	194
84	18	3	172	2260	198	17	2475	247
84	20	3	172	2511	220	17	2748	275
84	18	3 1/2	136	2092	198	17	2307	231
84	20	3 1/2	136	2324	220	17	2561	256
84	18	4	106	1871	198	16	2085	208
84	20	4	106	2078	220	16	2314	231

Figured on a basis of 10 square feet of heating surface per boiler horse power, the heating surface should include the inside tube area, one-half the area of the cylindrical portion of the shell, and two-thirds of the area of the rear head minus the combined cross-sectional area of the tubes.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE "Gas World," London, reports the following figures for the English gas companies for 1914 and 1915:

	1914.	1915.	Per Cent. Increase.
Gas made (millions).....	229,196	233,274	1.7
Total number of consumers.....	7,670,812	7,733,471	0.8
" " slot consumers..	3,951,519	4,094,424	3.6
" " cookers.....	3,765,207	4,022,666	6.8
" " public lamps....	779,442	780,703	0.2

LUDWIG TALBOT CUSTER, a prominent retired business man, president of the Consumers' Gas Company, and of the Adamstown and Mohnton Electric Railway Company, died of pneumonia at his home in Reading, Pa., on Christmas day. He was in his 81st year and had been ill only a week. Mr. Custer was a director in the following organizations: Kutztown and Fleetwood Electric Railway, United Traction Company, of Reading; Reading Power Company and the Schuylhill Valley Bank.

THE December gas output of Boston Consolidated Gas Company was 5,261,503,000 cubic feet, a decrease of 3.3%. November output decreased 1.98%.

DOWN at the Columbus, Ga., gas works, on the banks of the Chattanoochie, there is the blackest man you ever saw, and his name is Snow. For over 15 years Snow has been a faithful employee, but on Christmas Eve, 1915, he did not come to work, but sent word his wife was sick. There was a faint suspicion in Mac Dexter's mind that his man, black in skin and white in name, had come under the heading, "All Men are Liars." Two days afterward, Superintendent Dexter looked up from his desk, and there stood Snow, scraping and bowing like a be-fo-de-war nigger. He wanted to "make a borry," he needed some money. "You are a truthful negro, you are," said Mr. D. "Send word your wife is sick, right at the time the gas works needed you, and now you are here to make a borry!" Old Snow straightened up and said, "Deed I was telling you de truf. My wife sho' was sick, she sho' was, and I named de boy Dexter." President Dexter of the Southern Gas Association, "O K'ed" the "borry."—E. D. B.

THESE four years gas sales of the Rochester (Minn.) Light, Heat and Power Company, make a very satisfactory comparison:

1912.	1913.	1914.	1915.
$28,438.37	$34,741.46	$40,837.45	$50,653.24

President Sonntag should congratulate his general manager.

DURING the week of January 17th, the Lynn (Mass.) Gas and Electric Company held an exposition of modern gas appliances, at 19-23 Market street, in a store rented for the purpose. An interesting feature of the exposition was a demonstration of cookery, by Miss Caroline Putnam Webber, whose mission is not only to demonstrate the best methods of cooking, but also to show the women "how to keep the kitchen up-to-date and sanitary."

AT the January meeting of the Brockton (Mass.) Gas Light Employees Association, Supt. W. G. Von Gimmigen gave an address on "The Manufacture of Gas—Its Progress at the Local Plant." The new plan of suggestion boxes was discussed, and plans were formulated for a dance in Clark Hall. The committee includes Roderick Donnell, John E. Bagge and Maurice Nathan. The entertainment committee for the next meeting are William P. Morton, W. A. Jordan, E. B. Mooney and Joseph String.

E. G. COWDERY, President of the Peoples Gas Light and Coke Company, believes this year will be the best the country has ever had in general business. As to his company's prospects, he is quoted in a Chicago dispatch as saying: "Our business has improved noticeably in the past six months, but it is not yet normal. One of our problems is the sharp advance in the price of oil. We expect to secure substantial economies in operation of our proposed new coal gas process."

A LARGE part of Austria-Hungary is suffering severely from a shortage of coal. In Budapest the electric lighting of the streets has been suspended and private consumers have been notified that they may soon expect the cutting off of their supply. In Vienna, cooking by gas has been forbidden.

THE Citizens Gas and Electric Company, Waterloo, Ia., will be granted an electric franchise for a period of 25 years, if the voters approve of the plan at a special election to be held Feb. 14, the city council having adopted an ordinance providing for the granting of the franchise, subject to approval of the voters. In return for the privileges granted by the franchise, the company agrees to erect a modern power station, and to grant a material reduction in rates for electricity for lighting the streets and public buildings. The rates for private consumers was not taken up, as the council has the power, under the State law, to take up the matter at any time.

NEW rates for gas to be charged by the Pacific Gas and Electric Company in its district of Chico, Marysville, Napa and Colusa have been authorized by the California Railroad Commission. The rates are $1.50 a thousand for the first 5,000 cubic feet, $1 a thousand for the next 5,000, and 80 cents a thousand for all over 10,000 cubic feet. The minimum monthly charge is 50 cents.

THERE will be plenty of new mains laid this year. The Public Service Gas Company has awarded a contract for 606 tons of 4", 6" and 8" gas pipe to the United States Cast Iron Pipe and Foundry Company. The same founders have secured numerous small contracts aggregating 1,083 tons of 4", 6" and 8" pipe from the United Gas Improvement Company, and an order for 437 tons of 6" and 8" pipe for Haverhill, Mass. The city of Springfield, Mass., has placed a contract for 1,014 tons of 4" to 16" cast iron pipe with the Standard Foundry Company, at $32.41 for 4" pipe and $29.40, delivered, for 16" pipe.

WHEN J. A. Patten, manager of the Elkhart (Ind.) Gas and Fuel Company, appeared before the Public Service Commission with a request for permission to change its method of collecting monthly bills, the commissioners informed him they had no jurisdiction over the matter, but advised him to get the permission of the city officials. Mr. Patten has informally conferred with Mayor Smith and the city commissioners, and the new plan probably will go into effect next month. The bills will be collected by districts, of which there will be twenty-five, one for each working day, the meter reading being done by one man constantly engaged. The discount for prompt payment will be allowed as in the past.

THE Commercial Department of the Harrisburg (Pa.) Gas Company held its first monthly meeting of the year, January 11th, at the company's office, with a full attendance. Officers were elected and committees appointed for the ensuing year. An interesting paper on "Collections" was read by Mr. Walker, followed by a general discussion. The business session was followed by a smoker.

FORT MADISON, Ia., has plans to create a white way in the 600 block on Second street, by the merchants in that section of the business district. The plan is to install a series of gas arcs, to be placed on the buildings at distances of about 20 feet apart. Many of the property owners and merchants have already signified their intention of joining in the improvement, and it is believed that the installation of the lights will be complete before many weeks. Manager Moffatt of the Fort Madison Gas Light Company is very much interested in the movement.

THERE has been filed with the Second District New York Public Service Commission a petition of the Public Service Corporation of Long Island for permission to construct a distributing system in the incorporated village of Floral Park, Nassau County, and for approval of the exercise of a franchise granted by the village.

LIKE the price of coal, that of coke has been increased in Providence, Everet, Lowell and several other New England cities. President Dana D. Barnum, of the Worcester (Mass.) Gas Light Co., says the increase in price made in coke in other cities has resulted from the fact that some of the gas companies have been unable to get as much gas coal as they need, and, therefore, found it necessary to resort to using some of the coke, which otherwise would be

sold. In some of the cities, where the price of coal has advanced, there has been a rush for coke, and the prices have been advanced to protect their year-around customers.

ADVICES from Tampa, Fla., say that the Southern Utilities Company has purchased the plant and business of the Palatka Gas Light and Fuel Company, at Palatka. It is understood that additional machinery will be installed in the plant.

A WELL appointed banquet, good speakers and accompanying good fellowship marked the second annual banquet of the Roanoke Va., Gas Light Study Club. Tables were spread for about 75, and most of the seats were taken. In addition to the members of the club, there were a number of invited guests, including State Senator W. L. Andrews, Representative R. H. Willis, Judge W. R. Staples, Mayor C. M. Broun, R. H. Angell, G. G. Gooch, C. F. Cocke; and the Rev. G. Otis Mead. J. M. Wilson, President of the club, introduced the toastmaster, C. Francis Cocke, who presented the various speakers. Mayor Broun spoke humorously in part, picking as his subject, "The Lawyer in Politics." The next speaker was M. M. Milton, manager of the Roanoke Gas Light Company, who spoke of the "Public, Investor and Employee," along the lines of the "public be pleased." "It was," he said, "the duty of the employees of a public service corporation to make themselves valuable to the public by increasing their knowledge of the business. A corporation depends on the man at its head and the employees he has under him." He then spoke of the right and the wrong way for employees to treat customers, showing the resulting attitude of the customer toward the corporation. The last speaker on the program was George von Kromer, who read an interesting paper on service. He warned against indiscriminate service, which, he said, not only injured the business which rendered it, but those who received it, and spoke of the bankrupt law, and how it is used to dodge the payment of debts; of the credit which merchants sometimes extend to people who would be better off without it, and of the usual custom of banks covering checks on accounts overdrawn. These were abuses of service, said the speaker, which did both giver and receiver harm.

THE Anniston, Ala., "Star" says: "During the past few months all of the old machinery has been taken out of the gas plant and replaced with new, which more than doubles the possible output of the plant and gives it a sufficient capacity to take care of the normal growth of Anniston for the next ten years. Everything about the plant is new, from the retorts, where the "raw" gas is "distilled," to the 50-foot brick stack that carries off the smoke. The two principal by-products of the plant are coke and tar, and next year the Alabama Power Company intends to conserve the ammonia that is now wasted. Indeed, some of the new machinery recently installed was purchased with this object in view. All of the improvements were made with the idea of giving better gas and more efficient service, and this has been accomplished. Not only have new washers, purifiers and condensers been installed, but miles and miles of new pipe have been laid in Anniston, Oxford and Blue Mountain during the past few months, and miles of small capacity pipe have been removed and replaced by larger ones."

ACCORDING to reports, the American Gas Company, of Philadelphia, which controls companies in Wilkes-Barre, Hazleton and other places in Pennsylvania, is seeking to acquire control of the Scranton Gas and Water Company, although Vice-President Worthington Scranton, of the latter company, says that no offer has been made to the company, and that he does not know of any being contemplated.

UTILITIES COMMISSION NEWS.

INDUSTRIAL RATE FOR DOMESTIC CONSUMERS.—The Consolidated Gas, Electric Light and Power Company, Baltimore, Md., has filed with the Maryland Public Service Commission a new gas schedule, which provides gas for all domestic consumers for heating and all other service in excess of the consumers' present use, at a net rate of 35 cents per 1,000 cubic feet; and in its application to existing customers, the schedule furnishes gas at 75 cents net for all consumption up to that of the consumers' maximum month's consumption in the last year, provided the same is not less than 4,000 cubic feet per month, and at the exceptionally low price of 35 cents per 1,000 cubic feet for all gas used in excess of the said last year's consumption. New consumers will benefit through an equitable rating system.

The new rate will make possible, from now on, the automatic reduction of the average rate to all consumers, for the consumer getting part of his gas at 75 cents and part at 35 cents, will obtain an average rate that will automatically reduce itself as his consumption increases. This marks a new era in the equitable adjustment of gas rates and profits on a sliding scale, which is a great step in advance of the periodic reductions, which never conformed to the requirements of either the producer or the consumer.

In reducing the price on the company's present output to 75 cents net, in connection with the heating value standard approved by the United States Bureau of Standards, the Commission went as far as it could, leaving any margin of profit to the company. It is by considering only the additional cost of manufacturing and distributing the additional gas to be used, and the possibility of largely increasing the total consumption, that the company can see its way clear to make this low excess consumption rate. This action of the company makes possible and economical the freest and most unrestricted use of gas for all household purposes, securing greater comfort and convenience in the home, even to the possibility of house heating.

SECURITIES MUST BE AUTHORIZED BY COMMISSION.—Every evidence of debt operating as a lien upon the property of railroad companies in Texas which does not bear the approval of the State Railroad Commission is invalid and non-enforceable, according to the Supreme Court of that State.

The court's decision rests upon the statute known as the stock and bond law, and followed a suit against the maker and endorsers of four notes of $2,500 each, issued by the Glen Rose and Walnut Springs Railway Company, without the O. K. of the Railroad Commission. The validity of the statute was brought into question, the contention being that it contradicted the State constitution, but the court overruled this contention. It held that the purpose of the law was to give stocks and bonds a substantial and not merely a fictitious representation. In its ruling the court held:

"While the constitutional provision directs that corporations, which include railroad corporations, shall not do the things therein prohibited, it contains no regulations or formalities relating to the issuance of stocks and bonds which will put upon notice and protect the prospective stockholder or creditor in case the corporation has not in fact observed the constitutional injunction. That is precisely what the provisions of Chapter 16 do when they direct that stocks and bonds (notes) of railroad corporations not approved by the Railroad Commission and certified to in that respect by the Secretary of State upon the bond, shall be void. And whoever purchases the bond of a railroad company not properly certified has constructive notice of its invalidity. The effect of the rule is not dissimilar to the statutory rule with reference to one who purchases a negotiable note after maturity, or of one who purchases before maturity with actual notice. Accordingly no railroad corporation being permitted to issue bonds without observing the provisions of Chapter 16, and the bonds acquired by appellants showing upon their face to be the bonds of a railroad company without such certificate, such fact was notice to appellants that they were void, even though acquired before maturity."

MISSOURI ASSOCIATION APPOINTS UNIFORM RULES COMMITTEE.—The executive committee of the Missouri Association of Public Utilities has authorized the appointment of a committee which is to have full power to act in behalf of the association before the Public Service Commission of Missouri, when the latter body shall meet to consider the adoption of uniform rules and standards of service. George E. Hayler, Jr., president of the association, has appointed the following committee: J. D. Bowles, Springfield Gas and Electric Company; F. C. Pratt, Empire District Electric Company, Joplin; John Fay, Union Electric Light and Power Company, St. Louis; S. E. Bronson, Water, Power and Light Company, Ozark, Mo., and A. N. Richardson, Kansas City Electric Light Company.

Financial Notes.

THE California Railroad Commission has given authority to the PACIFIC GAS AND ELECTRIC COMPANY to issue $2,500,000 of first preferred stock and $2,000,000 of general and refunding gold bonds. The company is also authorized to use $2,473,046.58 cash on hand from the sale of preferred stock, together with $130,005 due on unpaid subscriptions for this stock, to reimburse its treasury for expenses from May 1, 1914, to August 31, 1915. The first preferred stock must net the company $90 a share and the bonds 85% of face value plus accrued interest. The funds received from the sale of the first preferred stock and the bonds will be used to reimburse the company's treasury for plant expenditure to August 31, 1915, in the sum of $491,744.43, and to pay for extensions, additions and betterments amounting to $3,150,000. This amount is necessary, the company believes, owing to the development of its business and the foreseen new consumers in 1916.

FOR the express purpose of financing the construction of a gas main in the district about Woodley Road, the GEORGETOWN GAS LIGHT COMPANY has filed application with the public utilities commission for authority to issue $150,000 5% bonds. It is stated that the proposed issue is to pay off the floating indebtedness of the company under the resolution of its board of directors, July 1, 1912, which authorized officers to borrow money for improvement and betterment of the property of the company on security of the company. Included under the floating indebtedness is the refunding of payments of notes outstanding, due on demand, and issued for capital requirements, and reimbursement to the company for expenditures of capital for extensions of mains and service during the past four years. The balance is for extending mains. The legal authority to issue the bonds, it is stated, is based on the act of Congress incorporating the company in 1854. The proposed issue is part of a $1,000,000 issue of bonds, of which $525,000 is now outstanding, and for which authority was given by stockholders of the company June 5, 1911. These bonds are 50-year bonds, dated from August 1, 1911.

HAVING sold an issue of $1,000,000 AMERICAN GAS COMPANY 100-year 6% gold bonds, purchased some time ago, William P. Bonbright & Co., Inc., has repurchased and is offering $62,000 of the same issue of 101 and accrued interest, yielding about 6%. Applicable earnings on these bonds, as officially reported, for the year ended Oct. 31, were also twelve times the interest requirements.

DIRECTORS of the CONSOLIDATED GAS, ELECTRIC LIGHT AND POWER COMPANY of Baltimore, fixed the price at which the common stock of the company will be sold to customers on partial payments, from January 10 to February 10, at $115 a share, or $1 a share higher than the price which was fixed between December 10 and January 10.

THE KALAMAZOO (Mich.) GAS COMPANY has passed out of existence, being succeeded by the MICHIGAN LIGHT COMPANY, which, under the provision of a warrant deed filed for record, takes over the entire property, business, grants and franchises of the old company. The purchase price named in the deed is $1, but attached to the document are $1,400 in revenue stamps, representing an actual payment of $1,400,000. The deed is signed by B. C. Cobb, president, who is also president of the Michigan Light Company. In taking over the Kalamazoo Gas Company, the Michigan Light Company acquires the entire stock holdings, including several single shares owned by individuals in the city, who were thus given voting power and legalized the existence of the company.

IN the recent successful financing by the STANDARD GAS AND ELECTRIC COMPANY, the company's 20-year 6% gold notes were offered to the public in a number of cities served by operating units, including San Diego, Pueblo, Oklahoma City, Mobile, Stockton and Ottumwa, and what was considered a satisfactory amount was taken for local investment. Newspaper advertising was used extensively by the company.

THE last quarter with the LACLADE GAS LIGHT COMPANY has been prosperous. Officials of the company say gross earnings will show a substantial gain. Operating costs have been gotten well in hand, and earnings for the year will probably show something like 8% for the common stock.

W. S. BARSTOW & COMPANY, Inc., report gross earnings of the combined properties of the GENERAL GAS AND ELECTRIC COMPANY as follows:

December.

1915.	1914.	Increase.	Per cent.
$252,441.46	$209,425.01	$43,016.45	20.5

Twelve Months Ending December 31.

1915.	1914.	Increase.	Per cent.
$2,430,435.76	$2,202,903.59	$227,532.17	10.3

Of the earnings of 1915, 66.2% were from electric light and power receipts; 19.9% from gas, and 13.9% from railway properties. The franchises of the subsidiary companies are perpetual, except in a few unimportant instances.

DIRECTORS of the PEOPLES GAS LIGHT AND COKE COMPANY, Chicago, have declared the usual quarterly dividend of 2%, payable February 25 to stockholders of record January 20. Books close February 10 for the annual meeting February 11.

CONTENTS.

AN ASTERISK (*) DENOTES AN ILLUSTRATED ARTICLE.

*GAS FIRED STEAM RADIATORS FOR HEATING APARTMENT HOUSES.—A SUCCESSFUL INSTALLATION, by H. Thurston Owens 49

FIREBRICK FOR BOILER FURNACES 50

*HISTORY OF THE DEVELOPMENT OF WATER GAS, by O. B. Evans 51

GEOLOGICAL SURVEY A BUREAU OF INFORMATION 54

REPORT OF THE COMMITTEE ON NOMENCLATURE AND STANDARDS OF THE ILLUMINATING ENGINEERING SOCIETY 55

EDITORIALS 56
Gas Heating Engineers—Ventilate by Gas Lights—I. E. S. Council Meeting—New Jersey N. C. G. A. Meeting.

OFFICIAL NOTICES—
Illuminating Engineering Society 57
Illinois Gas Association 57

GAS FOR WAR BALLOONS 59

CONTINUOUS DETERMINATION OF CALORIFIC VALUE OF GASES 60

NEW METHODS AND APPLIANCES 61
*Concrete Out-Door Purifiers—*Large and Small Units Alike—Heating Surface and Steaming Capacity.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 62
England's Output—L. T. Custer Dead—Boston December Decrease—He Stood for It—Four Years Growth—Lynn's Exposition — Brockton Employees' Association — Mr. Cowdery Optomistic—Austria is Short—Waterloo to Vote on New Franchise—New Pacific Rates Authorized—A Lot of Pipe—Continuous Reading in Elkhart—Harrisburg Commercial Department—Gas Arc White Way—Floral Park Franchise—Coke Up Because—Palatka Gas Light and Fuel Bought—Roanoke, Va., Meeting—Anniston Made Over—Scranton Company May Be Bought.

UTILITIES COMMISSION NEWS 63
Industrial Rate for Domestic Consumers—Securities Must be Authorized by Commission—Missouri Association Appoints Uniform Rules Committee.

Financial Notes 64

Public Lighting Table for Jan., 1916 (Ad. Section) 7

Meeting Times of the Various Gas Associations (Advertising Section) 21